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# **CATABus Operations Improvement Report**

Prepared for use by the Centre Area Transportation Authority

# Boarding Policies

Improve boarding speeds with all-door boarding and increase capacity with a fare-free zone on campus and downtown

**All-door boarding could reduce dwell-times by over 40%,** leading to 5 to 7 percent decreases in overall travel time

**San Francisco saw a decrease in fare evasion with proof-of-payment,** with the CATA revenue hours equivalent of two fare inspectors

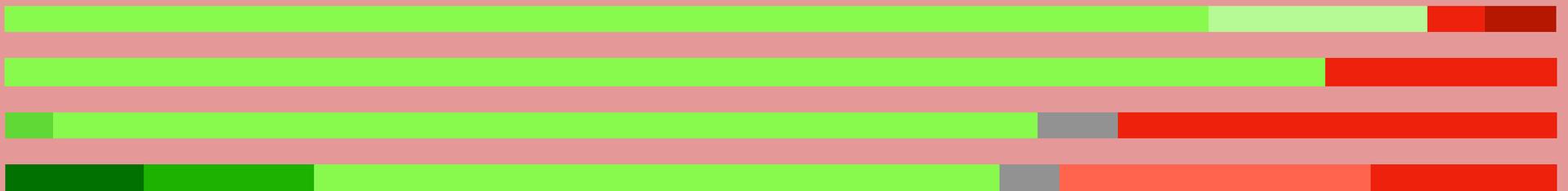
CATA Fare Mix

All-door boarding-ready fare types

Fare types requiring the farebox



Comparison agencies with various all-door boarding initiatives



**Introduce all-door boarding and proof-of-payment** to lower dwell times and allow for a fare-free zone

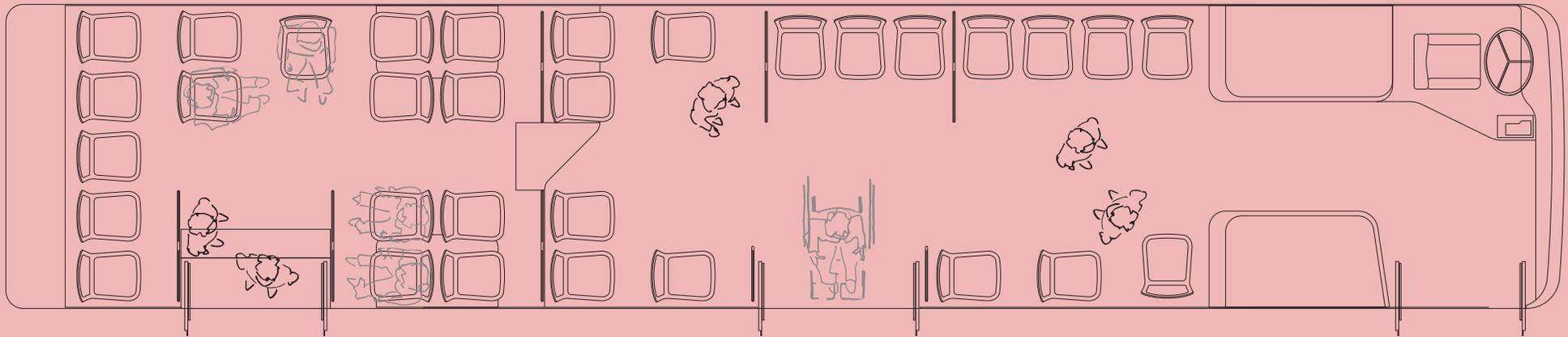
**Create a fare-free zone on campus and downtown** to supplement Loops and Links with additional capacity and routes

# Bus Layout

Amplify gains from boarding improvements by facilitating movement of riders at stops while maintaining comfort while traveling

**Purchase three-door 40 foot buses and four-door articulated buses** to remove the dead-end behind the middle door and decrease dwell times at stops

**Use single, forward facing seats and left-side wheelchair spaces** to increase standing room and reduce chokepoints



**Encourage more efficient standing patterns** with all-door boarding and announcements imploring riders to hold backpacks at their feet

**Use buses with wide doors and open layouts on crowded routes** to see dwell time reductions of 7 to 8 percent

**Explore electric powered buses,** including in-motion charging, overhead wires, and battery power

# Travel Infrastructure

Speed buses as they move through slow pedestrian-friendly corridors and congested car-oriented corridors



**Encourage development** around high-frequency bus corridors to increase ridership

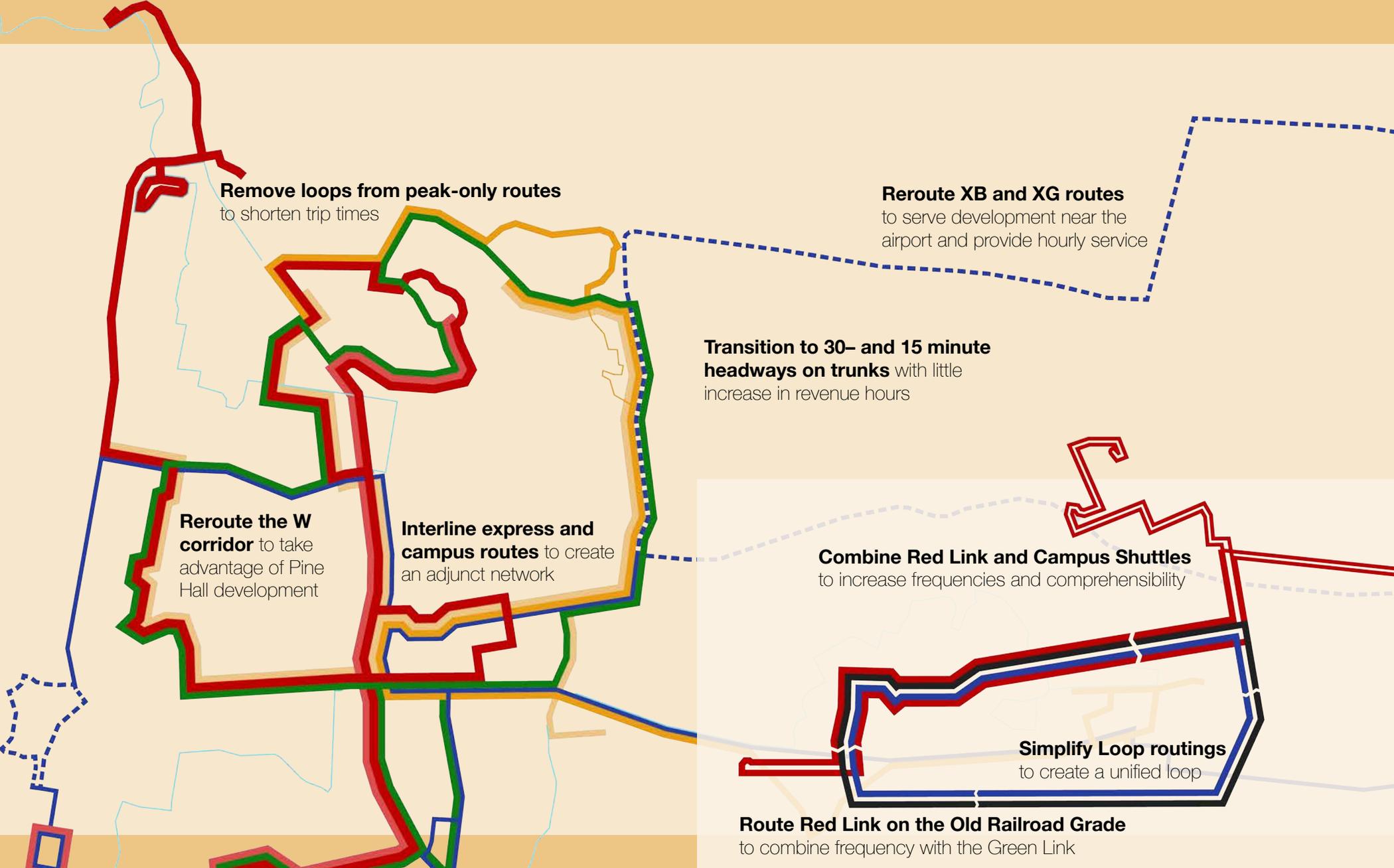
**Remove vehicles from campus streets** to allow buses to move while maintaining high pedestrian priority

**Use bus lanes and intersection improvements** to allow buses to bypass congestion

**Create visible bus infrastructure** to advertise rapid transit-like service to non-transit users

# Network Changes

Maximize efficiency of buses currently operating to speed trips and expand accessible destinations





# Organization Cooperation

Empower associated organizations and municipalities to improve transit by advocating for rider priorities

**Create guidelines for event road closures** to ensure consistent service to the most used bus stops

**Phase in system-wide apartment passes** to provide better value to tenants and encourage off-peak ridership

**Advocate for the removal of bus pull-offs**, which can increase travel delay by 300% when delay to bus riders is included

**Allow residential tower developments to support White Loop service** in exchange for lower minimum parking requirements

**Negotiate for more bus stop amenities** and better temporary construction mitigation measures

**Substantially increase bus shelter rollout**, as their benefit outweighs the cost at only 2.5 weekday boardings

# Report Objective

CATABus ridership has fallen consistently for the past few years,<sup>1</sup> mirroring but surpassing nationwide trends.<sup>2</sup> Possible factors include:

- Construction impacting system ease-of-use, speed, and reliability
  - Delays due to North Atherton Street construction on the N, V, and W trucks as well as the R trunk due to route interlining
  - Closed sidewalks due to construction at East Halls on Penn State Campus forcing students to backtrack to take the bus, encouraging many to walk instead
- Zagster bike share attracting some potential riders primarily from campus services, especially when routes are slow from congestion
- Ride-hailing apps attracting some potential riders from campus and community services, especially when frequencies are low late-night and on weekends
- Lower gas prices and subsidized parking downtown, on campus, and in the surrounding region encouraging some potential riders to drive

These factors are external to transit and outside the responsibilities of CATA. Therefore, CATA should focus on how it can increase ridership by changing its own policies, network, fleet, and interactions with other agencies without substantially increasing operations or capital spending.

**In brief, to increase ridership without increasing expenses.**



*A crowded White Loop waiting in traffic on Curtin Rd at Allen Rd*

<sup>1</sup> PennDOT, "CATA (Centre Area Transportation Authority)," Pennsylvania Public Transportation Performance Report – Fiscal Year 2016-17, April 30, 2018, 79; CATA, "Ridership by Service - Summary," CATABUS Web Statistics, June 19, 2019.

<sup>2</sup> TransitCenter, "All Transit Ridership is Local," Who's On Board 2019: How to Win Back America's Transit Riders, February 2019, 7.

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Proof-of-Payment & All-Door Boarding , Fare-Free Zone

## **Boarding Policies**

Improve boarding speeds with all-door boarding and increase capacity with a fare-free zone on campus and downtown

# Proof-of-Payment & All-Door Boarding

*Proof-of-payment can speed front-door boarding and allow for all-door boarding with a few roving fare inspectors and no increase in fare evasion.*

*All doors can be used to board community and campus buses, significantly decreasing boarding times, especially on articulated buses.*

## EXISTING CONDITIONS

**Buses are often significantly more full at the front because riders don't move toward the back, lowering capacity and slowing boarding. Some bus operators leave riders behind because the front is full, even when there is space in the back. This creates awful customer experiences.** Bus operators often tell standees at the front to move back by yelling or announcing through the speakers.

Some bus operators allow riders to stand in front of the yellow line when there is space in the back which could be unsafe and is illegal. Some bus operators tell passengers to enter from the rear door when they cannot fit in the front, slowing boarding. A few bus operators exit the bus and find room for passengers through the rear door themselves, significantly slowing boarding.

Campus services could employ all-door boarding today, if not for the potential for confusion on community routes.

Bus operators often leave their bus unattended with the doors open for breaks, and there is no fare enforcement to ensure boarding riders pay full fare. This invitation for fare evasion is not a major problem; therefore fare evasion with all-door boarding will likely not be a major problem.

## NEW ADVANTAGES

Elimination of unlimited pass swiping would improve boarding times significantly.

Boarding riders would be split between two or more doors, decreasing dwell times substantially. **San Francisco's MUNI system, run by SFMTA, realized a 38% drop in dwell times from the implementation of all-door boarding and proof-of-payment, with only a 25% increase in rear-door boarding.**<sup>3</sup> Whereas SFMTA started at 29% rear-door boarding, CATA would go from almost no rear-door boarding to near 50%, leading to potentially significantly higher dwell time drops. With a 40% reduction in dwell times from all-door boarding, overall trip times on campus and downtown could decrease by 5 to 7 percent:<sup>4</sup>

Blue Loop and Green Link from Walker Building to Pavilion Theatre

Current Trip Time	5m 6s
Improved Trip Time	4m 49s
Trip Time Reduction	17s
% Total Trip Reduction	<b>5.63%</b>

<sup>3</sup> San Francisco Municipal Transportation Agency, "Distribution of Dwell Times per Boarding and Alighting on Two-Door High-Floor Buses and Historic Streetcars," All-Door Boarding Evaluation Final Report, December 2014, 14.

<sup>4</sup> See [appendix](#) for raw data.

White Loop from Visual Arts Building to Elliott Building

Current Trip Time	5m 40s
Improved Trip Time	5m 17s
Trip Time Reduction	24s
% Total Trip Reduction	<b>6.91%</b>

Pattee Transit Center Eastbound to College Ave at Allen St<sup>4</sup>

Current Trip Time	8m 26s
Improved Trip Time	7m 54s
Trip Time Reduction	33s
% Total Trip Reduction	<b>6.48%</b>

By saving 2.5 to 3 seconds of boarding and alighting time per rider, CATA could gain 12 to 15 revenue hours per day in added efficiency,<sup>6</sup> to be used for increased service [ [see Increased Trunk Frequency](#) ]. All-door boarding also improved passenger perceptions of on-time performance in Montreal.<sup>7</sup>

Boarding through all doors allows riders to evenly distribute themselves to use all standing room efficiently.

Back-door boarding disincentives cash and token payment meaning faster boarding and less fare collection cost.

Only 6 percent of riders would need to pay via the farebox at the front door. At least 2 percent would be easily converted to non-farebox payment, as they are willing to spend time buying tokens for added convenience.

All-door boarding allows passengers to step out of a rear door to let others alight, without fear that the rear door will close before they get back in, as happens today to discourage rear-door boarding and fare evasion.

## ISSUES RESOLVED

Because some fare media will not be swiped for every boarding, alternate passenger counting methods will be necessary; potentially existing or new automatic passenger counters installed at each door.<sup>8</sup> Automatic passenger counters should be reset at the end of each trip, so errors are not carried into later estimates of passengers on board.<sup>9</sup>

All-door boarding will be less effective on older 40 foot buses because their rear doors are narrow and open out,

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<sup>5</sup> V, N, R, A, and G routes recorded on weekends, nights, or during reduced service. Weekday midday and peak percent reductions during normal service will likely be higher. See [appendix](#) for raw data.

<sup>6</sup> 2.5 to 3 seconds multiplied by 6.4 million riders annually yields 12.18 to 14.61 revenue hours per day: [CATA, "CATABUS Ridership Information," CATABUS Web Statistics, June 19, 2019](#); [Alon Levy, "Our Brooklyn Bus Redesign," Pedestrian Observations, September 19, 2018](#).

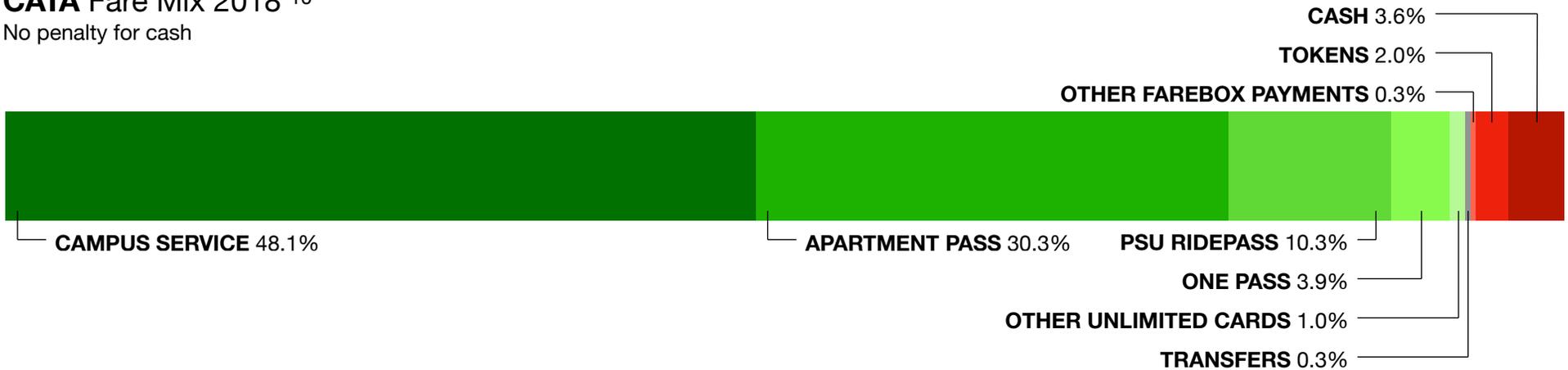
<sup>7</sup> [Ahmed El-Geneidy, Dea Lierop, Emily Grise, Geneviève Boisjoly, Derrick Swallow, Lesley Fordham, & Thomas Herrmann, "Get On Board: Assessing an All-Door Boarding Pilot Project in Montreal, Canada," Transportation Research Part A Policy and Practice 99:114-124, DOI: 10.1016/j.tra.2017.03.005, April 2017](#).

<sup>8</sup> [Amy Snyder, "Sampling Tests Automatic Passenger Counters," The Inside Lane, Champaign-Urbana Mass Transit District, September 26, 2011](#).

<sup>9</sup> [Christopher MacKechnie, "Automated Passenger Counting \(APC\) Systems: How Do They Work?" Liveaboutdotcom, Dotdash, May 24, 2019](#).

## CATA Fare Mix 2018 <sup>10</sup>

No penalty for cash



right where boarding passengers would stand, and because too many seats limit internal passenger movement [ [see Open-Layout Buses](#) ]. These old 40 foot buses should be used on less crowded routes now, and especially in the future with all-door boarding.

### STRATEGY OPTIMIZATION

These policies could be implemented in a semester-long system-wide pilot program [ [see Implementation](#) ], after which bus speeds and fare evasion rates can be evaluated.

Most riders on the CATA system do not need to use fareboxes to pay: Almost

half of riders are on Loop and Link routes, which are already free to use. If not for the confusion it would cause, these routes could implement all-door boarding today without any setup or costs. Another 46% of riders use unlimited-ride passes. Unlike some debit card-like passes at other agencies, these unlimited passes would need no swiping infrastructure, and would only be necessary for validation by fare inspectors. The small number of riders using transfers and the Token Transit mobile app would be able to skip the farebox and use their transfer slip or phone for validation with fare inspectors.

The 6 percent of riders using cash, tokens, etc. would need to enter via the front door and each receive a transfer slip as proof-of-payment. Speeding and discouraging cash and token payment methods to reduce front door payment boarding time should be a high priority. Strategies include:

- Speed handout of transfer slips
  - Pre-fill repeating time, date, and trip fields due to higher volume of transfer slips
- Explore automated transfer slip machines or alternatives. Example: New York bus operators hand out single-use metro cards when riders ask for a transfer, which can be used within two hours of paying the

<sup>10</sup> [CATA, "CATABUS Ridership Information."](#)

fare.<sup>11</sup> In CATA's case, these cards would be checked by fare inspectors rather than at fareboxes

- Encourage mobile ticketing
  - Add single ride functionality to Token Transit or similar app
  - Explore partnerships in which CATA receives higher percentage of fare revenue
- Advocate for mobile ticketing integrated into Avail MyStop app to improve rider convenience
- Advertise mobile ticketing options on transfer slips
- Incentivize alternate fare media
  - Increase cash and possibly token fare price or discount mobile ticketing and pass price
  - Explore all-door boarding-compatible single fare alternatives for riders without a smartphone
  - Explore non-price related incentives for half-fare riders
- Explore off-board payment
  - Explore ticket machines for cash and token riders at key stops with high amounts of boarding

It would be possible for routes operating less than hourly to be exempt from all-door boarding and proof-of-payment because they rarely

have dwell time problems due to crowding, using separate branding or small buses to limit confusion. However, with proof-of-payment, fare inspectors could check less often because a higher proportion of mostly-commuter riders would use unlimited passes, so one simpler fare system and universal all-door boarding would probably be superior.

### FARE ENFORCEMENT

Fare enforcement should be handled by pairs or groups<sup>12</sup> of fare inspectors roving buses while the bus moves between stops.

Special care should be given to balancing fare revenue with rider experience, especially with many new students each year. For example, fare inspectors could issue warnings rather than fines for the first week of each fall semester, but there could be more fare inspectors that first week than normal to establish that non-paying riders will be caught. Additionally, each fare inspector could have a list of all unlimited pass holders, and give a warning rather than a fine to anyone without a fare who could prove they were on the list, to eliminate the



*A transfer slip which has been manually filled out by the bus operator*

problem of riders forgetting their card the day they meet a fare inspector.

**At the same proportion of fare inspectors to revenue miles as the SFMTA system in San Francisco, CATA would need less than two fare inspectors for its community**

<sup>11</sup> "How to Ride the Bus," Metropolitan Transportation Authority, accessed July 21, 2019.

<sup>12</sup> Jason Lee, "Uncovering San Francisco Muni's Proof-of-Payment Patterns to Help Reduce Fare Evasion," San Francisco Municipal Transportation Agency, November 15, 2010, 12.

**routes.**<sup>13</sup> The actual required number might vary between two and four based on the following factors:

- A fare-free zone on campus [ [see Fare-Free Zone](#) ] would significantly reduce the number of revenue miles where fare inspection is necessary
- A significantly higher proportion of CATA riders use unlimited passes than SFMTA riders, making fare enforcement faster and easier and removing the possibility of fare evasion for most riders
- Because CATA routes are less frequent on average than SFMTA routes, fare inspectors might need to wait longer between inspecting buses, leading to lower efficiency

The most efficient enforcement method might be for fare inspectors to go back and forth on each bus on the N Atherton St corridor, at The Colonnade, and in the vicinity of S Atherton St at S Allen St, then randomly check other corridors so riders can't establish a pattern. Alternatively, fare inspectors could check riders alighting buses at major stops as SFMTA does<sup>14</sup>, like apartment complexes. Even with a fare-free zone [ [see Fare-Free Zone](#) ], riders alighting from routes whose first stop on campus is Pattee Transit Center could be inspected there as well. Fare inspectors should not stop buses for fare inspections, as this reduces the effects of lower dwell time and intensifies animosity between riders and fare inspectors.<sup>15</sup>

Fare inspectors should be deployed strategically at times with higher potential fare evasion. SFMTA finds fare evasion rates are low on weekday mornings and get progressively higher into the afternoon and evening. Weekends have fare evasion rates similar to weekday afternoons and evenings.<sup>16</sup>

**Fare evasion fines should be set higher than the normal fare multiplied by the average number of rides between fare inspections.** At SFMTA, fines for not having the correct fare are \$75.<sup>17</sup>

**Number of fare inspectors and fine amounts can be changed to influence fare evasion rates.** After the implementation of all-door boarding,

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<sup>13</sup> Campus routes are 22.3% of CATA's total yearly revenue miles (381,027.70 campus / 1708475.20 total), therefore community routes are 77.7%. SFMTA has 54 fare inspectors for 3,625,884 yearly revenue hours versus CATA community routes' 131,628.5 (169,406 with campus services); meaning proportionally CATA needs 1.96 fare inspectors (2.52 including campus services): [TransitCenter, "Better Boarding, Better Buses: Streamlining Boarding & Fares," National Association of City Transportation Officials, February 2017, 6](#); [San Francisco Municipal Transportation Agency, "Average Annual Transit Cost per Revenue Hour," San Francisco Municipal Transportation Agency, August 22, 2018](#); [PennDOT, "CATA \(Centre Area Transportation Authority\)," Pennsylvania Public Transportation Performance Report – Fiscal Year 2016-17, April 30, 2018, 79](#); [Centre Area Transportation Authority, "Budget FY 2018/19," Centre Area Transportation Authority, 2018, 27](#).

<sup>14</sup> [Jason Lee, "Uncovering Proof-of-Payment," 12](#).

<sup>15</sup> [Alon Levy, "Fare Payment Without the Stasi," Pedestrian Observations, August 15, 2018](#).

<sup>16</sup> [Jason Lee, "Uncovering Proof-of-Payment," 8](#).

<sup>17</sup> [ibid, 3](#).

### CATA 2018

No penalty for cash



### BOSTON MBTA 2016<sup>18</sup>

50¢ cash and ticket penalty<sup>19</sup>



### NEW YORK MTA 2017<sup>18</sup>

25¢ ticket penalty<sup>19</sup>



### SAN FRANCISCO SFMTA 2017<sup>18</sup>

50¢ cash and ticket penalty<sup>19</sup>



### PHILADELPHIA SEPTA 2017<sup>18</sup>

50¢ cash penalty



fare evasion on SFMTA vehicles decreased.<sup>20</sup> Small amounts of fare evasion should be tolerated as a necessary part of speeding service and reducing fare collection costs.

## OPPORTUNITIES & POSSIBILITIES

Three- and four- door articulated buses and three-door 40-foot buses can have multiplied positive dwell time effects with proof-of-payment and all-door boarding [ [see Additional & Expanded Doors](#) ].<sup>21</sup>



Systems that provided data have reported better fare compliance than with front-door bus operator fare control.<sup>19</sup>

Proof-of-payment makes a fare-free zone on campus viable [ [see Fare-Free Zone](#) ].

As potentially the second transit agency in the United States to implement all-door boarding, with a system much smaller than other US cities looking at proof-of-payment, CATA could shape industry best-practices and help accelerate proof-of-payment and all-door boarding policy implementation in the US.

## NATIONAL COMPARISONS

CATA is well positioned to implement all-door boarding and proof-of-payment:

- Because campus service is free, half of CATA's ridership does not require fare enforcement
- **CATA's pass system only uses unlimited passes, so no card-reading infrastructure is necessary at rear doors and no payment infrastructure is necessary at stops**
- Only 5.9% of fare media used requires a farebox, and a cash penalty would reduce this further

San Francisco's SFMTA has implemented all-door boarding on their entire local bus network even though:

- 28.2% of fare media requires a farebox, even with a 50 cent penalty

<sup>18</sup> ["Cashing Out on Bus Reliability," DaTa Blog, Massachusetts Bay Transportation Authority, July 21, 2016;](#) [Scott Stringer, "The Other Transit Crisis: How to Improve the NYC Bus System," Office of the New York City Comptroller, November 27, 2017;](#) [Ed Reiskin, "Balancing the Transportation Needs of a Growing City: FY 2019 and FY 2020 Operating Budget," SFMTA Board Meeting, San Francisco Municipal Transportation Agency, February 20, 2018;](#) [Jarrett Walker + Associates, "Philadelphia Bus Network Choices Report: Network Assessment," Southeastern Pennsylvania Transportation Authority, June 2018, 71.](#)

<sup>19</sup> [Massachusetts Bay Transportation Authority, "Subway Fares," Fares Overview, accessed July 21, 2019;](#) [MTA, "How to Ride the Bus;" San Francisco Municipal Transportation Agency, "Single Ride - Adult," Fares, July 1, 2019;](#) [Southeastern Pennsylvania Transportation Authority, "Cash, Tokens, Transfers," Fares, accessed July 21, 2019.](#)

<sup>20</sup> [San Francisco Municipal Transportation Agency, "Principal Findings," All-Door Boarding Evaluation Final Report, December 2014, 12.](#)

<sup>21</sup> [TransitCenter, "Better Boarding," 2.](#)

Jarrett Walker and Associates recommends Philadelphia's SEPTA implement all-door boarding on their entire network<sup>22</sup> even though:

- 32% of fare media requires a farebox
- 12% of fares are paid in cash, even with a 50 cent cash penalty and a one dollar transfer penalty

Boston's MBTA is moving toward fare payment compatible with all-door boarding on all buses<sup>23</sup> even though:

- 8.2% of fare media requires a farebox, even with a 50 cent cash penalty and a full-fare transfer penalty<sup>24</sup>
- Reloading CharlieCards—otherwise all-door boarding ready fare cards—and Charlie Tickets on buses requires six steps while boarding: press a button, tap fare card or insert ticket, insert cash, press a button, tap fare card again or remove ticket, tap fare

card a third time or insert and remove ticket again to pay<sup>25</sup>

New York's MTA has implemented all-door boarding on Select Bus Service (SBS) routes and plans to expand all-door boarding to all buses even though:

- Because of high cash use and constraints of the existing payment card system, expensive off-board fare payment kiosks are installed at every SBS stop
- A new OMNY fare payment system is necessary to allow for full implementation of all-door boarding, with card readers at every door of every bus<sup>26</sup>

CUMTD in Champaign-Urbana, Illinois employs all-door boarding at select 'iStops,' without any proof-of-payment, although University of Illinois students ride free. Dwell times at these stops was reduced by up to seven minutes.<sup>27</sup>

## **WHY THIS TIME IS DIFFERENT: PROOF-OF-PAYMENT**

In the early 2000s, select Centre Line buses were fare-free to increase capacity on campus, allowing more people to use CATA to move around. However, the limited amount of participating routes meant crowding was severe and riders trying to get to destinations off-campus had trouble using the bus. Additionally, it was difficult to ensure separation of fare-free riders and paying riders when buses left the fare-free zone. Without transforming the fare system, there was no way to distribute the crowding evenly and control payment without the system becoming too confusing.

Proof-of-payment allows for seamless fare-free zone integration. Passengers traveling around campus would enter

<sup>22</sup> Jarrett Walker + Associates, "Philadelphia Bus Network Choices Report: Is Transit Useful? Key Indicators," Southeastern Pennsylvania Transportation Authority, June 2018, 42.

<sup>23</sup> Massachusetts Department of Transportation, "Fare Collection Technology," MBTA Fare Policy, December 21, 2015, 6.

<sup>24</sup> Massachusetts Bay Transportation Authority, "Transfers," Fares Overview, accessed July 21, 2019.

<sup>25</sup> Massachusetts Bay Transportation Authority, "Bus Fares," Fares Overview, accessed July 21, 2019.

<sup>26</sup> New York City Transit, "Reimagine the Bus Network," Metropolitan Transportation Authority, May 2018, 35; Colin Wright & Vincent Pellecchia, "A New Way to Ride," TransitCenter, February 26, 2018.

<sup>27</sup> Foursquare Integrated Transportation Planning, "Assessment of Articulated Bus Utilization," Centre Area Transportation Authority, October 2017, 116.

the bus like all other passengers using unlimited passes or the mobile app. Fare inspectors would stop checking fares while buses were within the fare-free zone, so the passengers who didn't pay a fare wouldn't ever have to show a pass. Buses leaving campus would have fare inspectors as well, meaning there would be no problem collecting fares outbound as there were with a fare-free zone when fares were collected upon boarding.

Because of the advantages of proof-of-payment, all routes could participate in the fare free zone, meaning less crowding on individual buses. All-door boarding and bus layout changes could also help eliminate crowding concerns.



Riders boarding using only the front door

**White Loop**  
**Blue Loop**  
**Green Link**  
**Red Link**

Enter any door  
 Let riders out first

**Other Routes** Keep card, phone, or transfer slip at hand for fare inspectors

Enter any door:  
 Token Transit Mobile Payment  
 Apartment Pass  
 PSU RidePass  
 One Pass  
 Other Unlimited Passes  
 Transfer Slip

Enter front door only:  
 Cash or token  
 Other farebox payment

On Loops and Links or with an Unlimited or Mobile Pass

**BOARDED EITHER DOOR**

Hand-out to be distributed to riders, explaining all-door boarding and proof-of-payment procedures. See [appendix](#) for full letter-sized and editable versions.



Advertisement for all-door boarding. See [appendix](#) for full poster-sized and editable versions.

**ALL DOOR  
BOARDING  
IMPROVES  
BOARDING  
TIMES BY  
40%**

# **BOARD EITHER DOOR**

On Loops and Links or with  
an Unlimited or Mobile Pass



Advertisement for all-door boarding showing dwell time benefits. See [appendix](#) for full poster-sized and editable versions.

# Fare-Free Zone

*With proof-of-payment, fares can be enforced on parts of routes only where CATA would like them to be. This makes a campus and downtown fare-free zone simple for riders and for CATA.*

## NEW ADVANTAGES

Because proof-of-payment would be hard to enforce on campus with heavy crowding and closely spaced, high volume stops, a fare-free zone would make official what would otherwise become operationally efficient, leading to better rider experience.

Community routes would provide much needed additional capacity and sorely desired increased frequency to existing Loop and Link service on campus and downtown, with no increase in operational expenses. Few if any riders pay to use community routes to move around on campus and downtown because of free Loop and Link service, so increases in passengers would come from existing and potential Loop and Link riders attracted by increased frequency and capacity, and there

would be virtually no revenue loss. For example, R, RC, UT, HM, and P buses would increase frequency and capacity of Blue Loop and Green Link routes from the Walker Building stop into Central Campus, potentially obviating the need for the Green Link on the western side of campus. **Because many riders exit these buses at Walker Building, there would be extra capacity. Additionally, because riders downtown board most routes when the bus comes back from campus, fare-free zone riders would not stop off-campus riders from boarding.**

Community routes would provide new, faster fare-free connections on campus and downtown, increasing ridership with no increase in operational expenses. For example, V, N, R, W, and other routes would provide a connection from North-central campus at the Visual Arts Building and the Computer Building bus stops to downtown around Garner St. This would be faster than the current Loop alternatives: the White Loop goes through congested central campus and downtown near Allen St, and the Blue Loop detours through stadium parking. **Because many paying riders alight at Pattee Transit Center and board at College and Allen or the Walker**

**Building stops, there would be room on buses between these stops for this fare-free shuttle service.**

**In general, crowding would not interfere with off-campus riders because off-campus riders alight on campus and downtown during the morning peak, and the afternoon peak is spread through the evening, leading to less crowding.**<sup>28</sup>

Newly fare-free route segments, added capacity, and improved frequency would increase ridership, potentially leading to increased funding.

## STRATEGY OPTIMIZATION

Announcements on buses should clearly articulate the end of the fare-free zone before the last fare-free stop. This ensures passengers unfamiliar with Community Routes notice that the bus will leave campus and downtown.

Most riders will not use community routes in the fare-free zone unprompted. **This means CATA can steer riders to use fare-free routes as it wishes, and avoid any potential negative crowding effects.** Many students who use Loop routes are intimidated by the Red Link because it travels away from the core of campus. Because peak-only routes are difficult

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<sup>28</sup> Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 20-94.

# LET DOWNTOWN GET FASTER

Board a V, N, W, or R bus across the street for the fastest trip to Chipotle

All CATA buses are  
free on campus  
& downtown.



*Advertisement for a fare-free zone advertising a specific use case. Shows how advertising can minimize impacts based on need: peak-only routes are not mentioned and generally will not be used. See [appendix](#) for full poster-sized and editable versions.*

to memorize and not very useful for shuttle trips, they will see extremely limited effects.

## **OPPORTUNITIES & POSSIBILITIES**

Penn State would receive significantly more free service on campus for the same price they pay for existing Loop and Link Service. This could be leveraged for future increases in funding of Loop and Link service.

Community services could be branded as Loop and Link routes on campus, to encourage fare-free ridership. For example, the K route could follow the Red Link from West Campus to central campus and be branded as a Red Link inbound and the K route outbound.

[Additional & Expanded Doors](#) . [Open-Layout Buses](#) . [Articulated Buses](#) . [Other Notes](#)

## **Bus Layout**

Amplify gains from boarding improvements by facilitating movement of riders at stops while maintaining comfort while traveling

# Additional & Expanded Doors

Purchase articulated buses with four or five wide-door sets only.

Purchase 40 foot buses with three wide-door sets as old buses are replaced.

## EXISTING CONDITIONS

Although articulated buses could ease capacity problems, they would maintain or exacerbate speed and reliability concerns without concurrent door design changes.

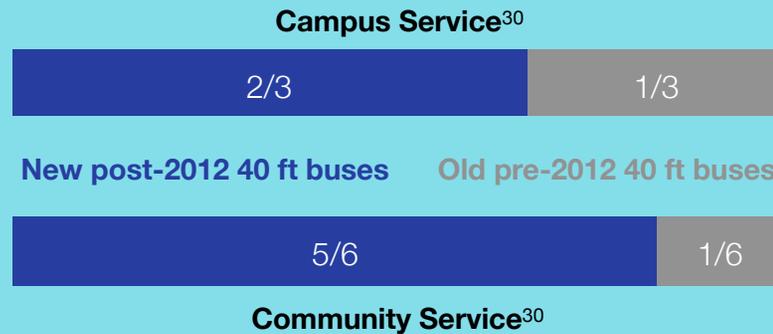
## NEW ADVANTAGES

Articulated buses will replace two existing buses with two doors each on the VE and RC routes, so an articulated bus with three doors will mean a reduction in doors overall. Four of five door set articulated buses would allow for equivalent or better than existing boarding times. All-door boarding [ [see](#)



Three door 40 foot bus in Helsingborg, Sweden; common across Europe

Narrow rear doors and seats blocking the rear exit [ [see Open-Layout Buses](#) ] on old 40 foot buses slow alighting, especially on Loop routes which disproportionately get old buses, presumably because passengers are not paying a fare. **In a study of 329 CATA stop dwell times, post-2012 New Flyer and Gillig 40 foot buses had 7.6% lower dwell times than their older 40 foot bus counterparts, and those buses on Loop and Link routes had 8.4% lower dwell times.**<sup>29</sup>



<sup>29</sup> With the caveat that type of bus was not randomized for each trip. See [appendix](#) for raw data.

<sup>30</sup> With the caveat that route and time of day were not randomized for each trip. From 90 campus service trips and 24 community service trips on 40 foot buses. See [appendix](#) for raw data.

## 40' 2 Door

Common in N America

## 40' 3 Door

Common in Europe<sup>31</sup>

Current Worldwide Use

Capacity (New Flyer Xcelsior model)

83

more than 83

Approx max distance between doors

20 ft

20 ft

Approx distance to last door from back of bus

13 ft

NA

Passengers per alighting door

41.5

27.67

New Flyer Xcelsior Specifications

Standard

Not Offered

Proof-of-Payment & All-Door Boarding ] is also required for the number of boarding doors to be equivalent between two 40 foot buses and one articulated bus. Where articulated buses will replace one 40 foot bus, four or five doors are still important to allow for increased ridership due to higher capacity without increased dwell times.

Three door 40 foot buses can be used on Loop routes, to increase internal passenger movement and capacity without articulated buses, which would increase capacity but might come with reduced frequency.

Doors create more standing room and less room for seating which increases capacity, and adding doors is not passenger-hostile whereas removing seats with nothing to replace them could be seen as passenger-hostile.

### All-Door Boarding



minimum proposed



proposed

Suggested CATA Use

Passengers per boarding door

41.5

27.67

### Front-Door Boarding



existing



discouraged

Suggested CATA Use

Passengers per boarding door

83

83



Three door 60 foot bus in New York City with unfortunately narrow middle and rear doors

## 60' 2 Door

## 60' 3 Door

## 60' 4 Door

## 60' 5 Door

Current Worldwide Use

Outdated in N America<sup>31</sup>

Common in N America

Common in Europe<sup>31</sup>

Common in BRT systems

Capacity (New Flyer Xcelsior model)

123

more than 123

more than 123

more than 123

Approx max distance between doors

40 ft

20 ft

20 ft

17 ft

Approx distance to last door from back of bus

13 ft

13 ft

NA

NA

Passengers per alighting door<sup>32</sup>

61.5

41

30.75

24.6

New Flyer Xcelsior Specifications<sup>33</sup>

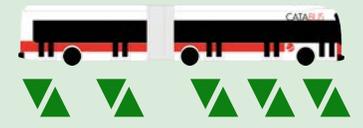
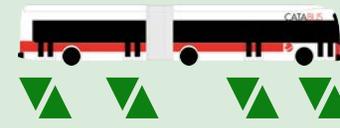
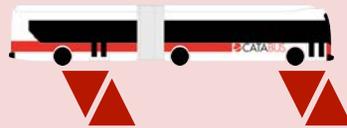
Standard

Standard

Option

Option

### All-Door Boarding



Suggested CATA Use

**discouraged**

**minimum proposed**

**proposed**

**future potential BRT**

Passengers per boarding door<sup>34</sup>

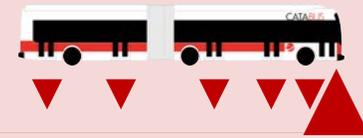
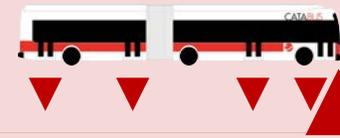
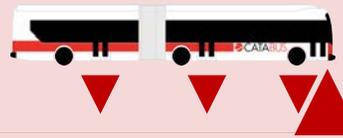
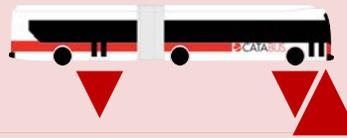
61.5

41

30.75

24.6

### Front-Door Boarding



Suggested CATA Use

**strongly discouraged**

**strongly discouraged**

**strongly discouraged**

**strongly discouraged**

Passengers per boarding door<sup>34</sup>

123

123

123

123

## STRATEGY OPTIMIZATION

Ensure doors are as wide as possible to reduce friction of passenger movement and allow multiple people to board and alight simultaneously, like the rear doors of existing CATA New Flyer and Gillig buses.

Work with international or national manufacturers to produce three-door 40 foot buses for sale to all United States transit agencies to reduce unit cost.

## OPPORTUNITIES & POSSIBILITIES

Explore adding buttons for opening doors and wheelchair ramps inside and outside the bus so doors do not have to open when there are no passengers using the door, and bus operators do not have to control opening and closing all doors.

Electric powered buses could more easily accommodate a third door at the back of the bus [ [see electric powered buses](#) ].<sup>35</sup>



*Four door 60 foot buses in Oslo, Norway with buttons for opening doors and wheelchair ramps outside the bus*

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<sup>31</sup> [Alon Levy, "The Dynamics of Bus Bunching," Pedestrian Observations, August 18, 2018;](#) ["Exqui.city," Van Hool, March 30, 2018.](#)

<sup>32</sup> ["Xcelsior: Choose Your Way Forward," New Flyer Industries, September 2017.](#)

<sup>33</sup> Passenger volume per door calculated by dividing average capacity by number of doors. Articulated buses would be less crowded as a percentage of their maximum capacity than 40 ft buses at the same ridership, but reduction in number of buses on routes (specifically VE and RC tripper buses) and induced demand from faster buses with higher capacity (specifically on Loops) will mean trips at capacity will increase ridership and stay at or near capacity with articulated buses. However, boarding and alighting times grow exponentially with crowding, so less crowded articulated buses would have significantly less dwell time.

<sup>34</sup> Actual passenger volume per door will vary between doors. For example, more passengers will exit at doors in the middle of buses rather than at the ends because the middle doors are closer to more space inside the bus. Additionally, more passengers will board via front and middle doors than rear doors because when unprompted, passengers generally wait at the front of stop platforms. This effect is more pronounced on buses with fewer doors and on larger buses operating routes which are also served by smaller buses because the front doors are the only ones which predictably stop at the same place.

<sup>35</sup> ["The Mercedes-Benz Citaro Goes Electric," Mercedes-Benz, March 30, 2018.](#)

# Open-Layout Buses

*Increase capacity and space for internal passenger movement in new buses by changing seating and removing chokepoints.*

## EXISTING CONDITIONS

Chokepoints on post-2012 New Flyer and Gillig buses create uneven crowding and limit internal passenger movement.

Express buses can not stop on Atherton St because riders take too long to alight from crowded buses.

## NEW ADVANTAGES

More open spaces and fewer chokepoints, in addition to more doors [ see [Additional & Expanded Doors](#) ], allow for more efficient internal passenger movement at stops, decreasing stop dwell time. Passengers can more easily alight crowded buses, allowing express buses to stop on Atherton St. Easier alighting also makes a hub on Atherton

## SEAT LAYOUT

There are four typical seating arrangements which can be used together to balance comfort and capacity.

[ A ] **Double/double forward-facing seats** provide the most seated capacity but provide the lowest overall capacity when standees are counted. The narrow aisle significantly slows movement, even when the bus is not crowded. This arrangement should be used away from doors for passengers going long distances.

[ B ] **Aisle-facing seats** are undesirable because of middle seats, which force some riders to sit between two strangers.<sup>36</sup>

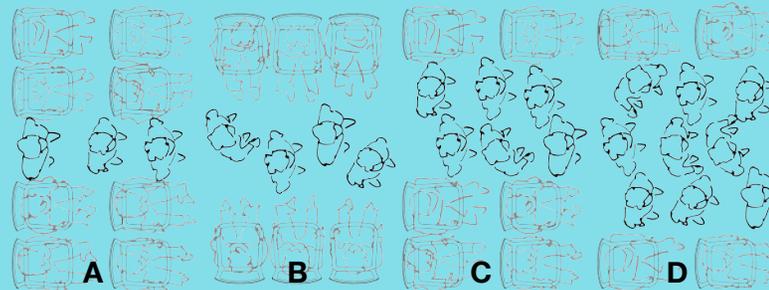
**Additionally, only one staggered row of riders is able to stand because sitting riders must have space for their legs and expect**

**slightly more personal space in front of them than they would from someone standing to their side.**<sup>37</sup>

These seats work well as folding seats over spaces for wheelchairs and in spaces without the length necessary for front-facing seats.

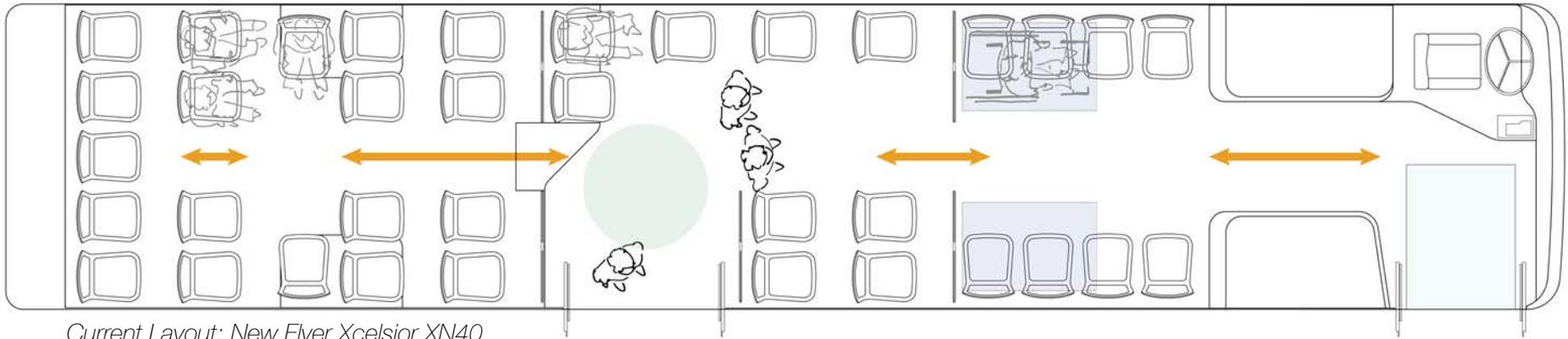
[ C ] **Double/single forward-facing seats** allow two people to stand next to each other. This arrangement balances seating and standing capacity, but the same balance can be achieved with different seating in two separate sections of the bus.

[ D ] **Single/single forward-facing seats** provide the most capacity of any arrangement: three standees can stand next to each other, slightly staggered. Single forward-facing seats are preferred by most single riders.<sup>37</sup> This arrangement allows for passenger movement and is especially useful near doors.



<sup>36</sup> Keith Barry, "The Ideal Subway Seating Arrangement? No Middle Seats," Wired, Condé Nast, April 16, 2013.

<sup>37</sup> Bjorn Swenson, "The Space Fallacy of Aisle-Facing Seating," Seattle Transit Blog, September 23, 2014.



Current Layout: New Flyer Xcelsior XN40

at Blue Course [ see Atherton Hub ] more efficient.

bus, allowing for increased capacity and easier passenger movement at stops.

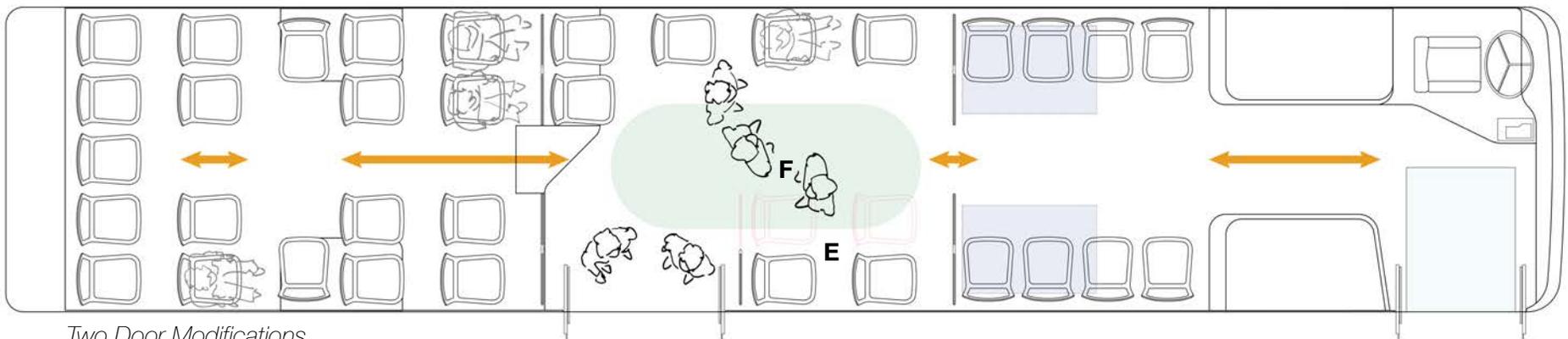
is relatively crowded, when standing capacity and movement are more important than seating capacity.

### TWO DOOR MODIFICATIONS

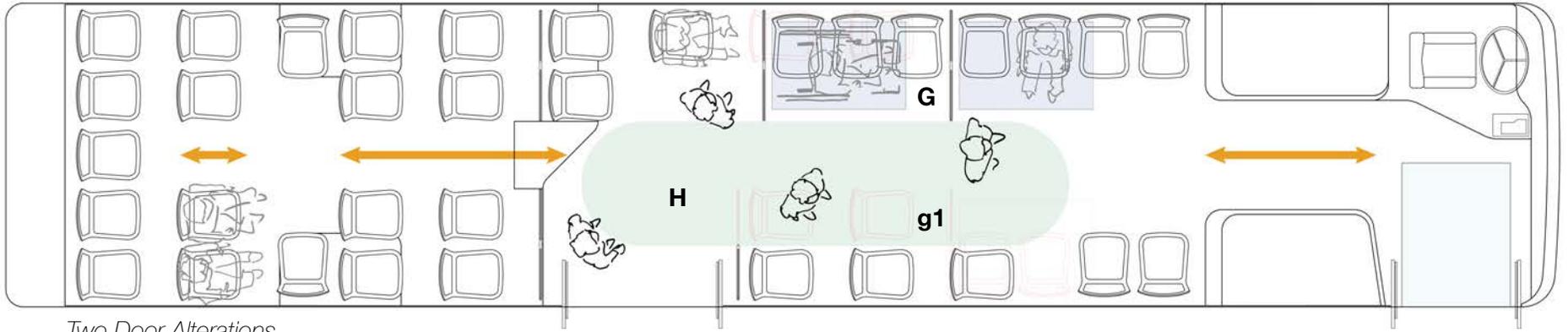
Two seats and a partition [ E ] can be removed from existing buses to create a large open area in the middle of the

Single seats are more valuable than each of their two seat equivalents because there is no possibility of sitting next to a stranger. Many double seats are used by only one rider until the bus

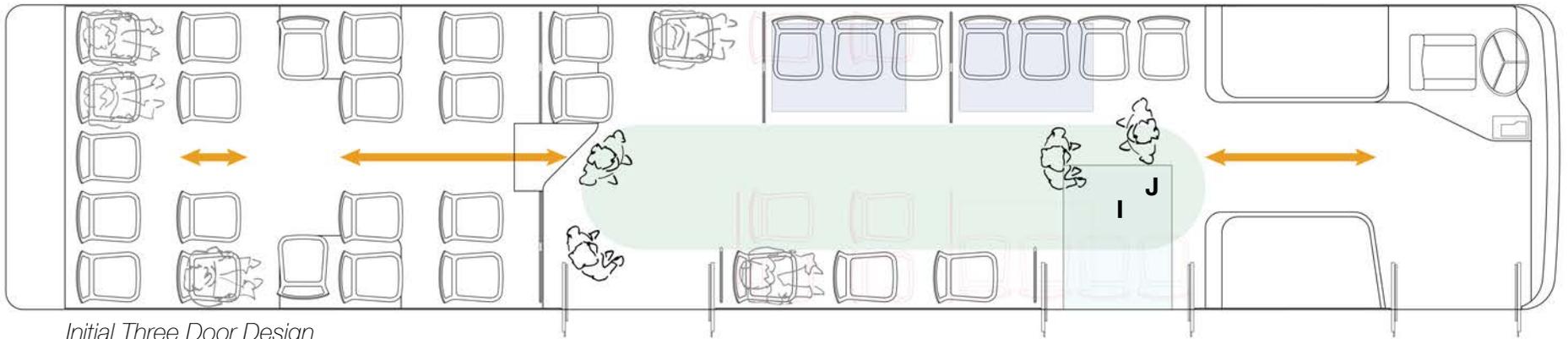
Open space for movement [ F ] will help especially with the implementation of all-door boarding [ see Proof-of-Payment & All-Door Boarding ], when riders will be boarding and alighting



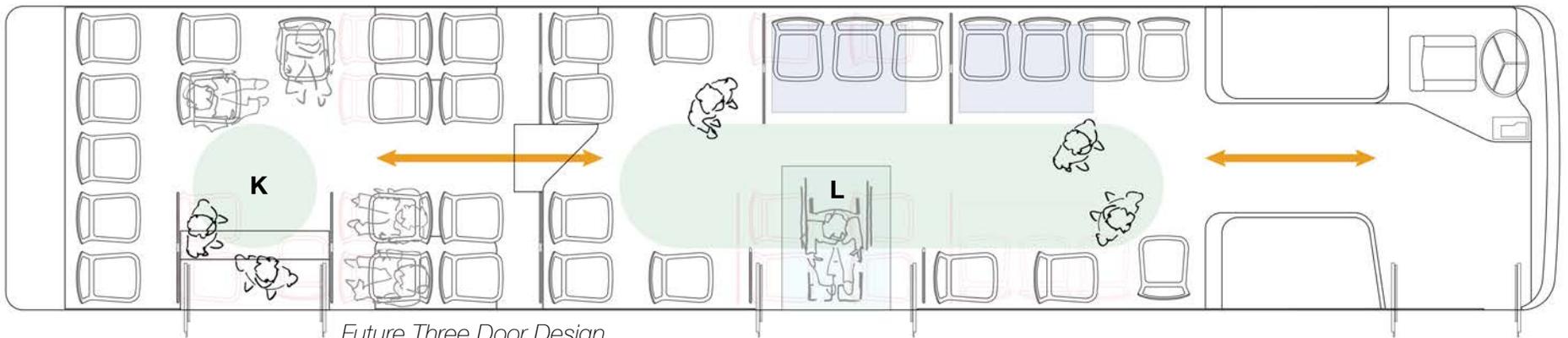
Two Door Modifications



Two Door Alterations



Initial Three Door Design



Future Three Door Design

from the middle door.

## TWO DOOR ALTERATIONS

New 40 foot buses should host an expanded open space with fewer chokepoints, to facilitate movement.

Both wheelchair spaces and aisle-facing seats should be moved to the left side of the bus [ **G** ],<sup>38</sup> clearing the right side of seats and partitions more than one seat-width wide [ **g1** ], and removing one chokepoint.

The wide middle door is able to continue and expand the open space [ **H** ] because there is little else in the way on the right side of the bus.

## INITIAL THREE DOOR DESIGN

To accelerate the introduction of three-door 40 foot buses in the US, the third door can be added between the existing doors [ **I** ], so no changes to the engine compartment below the high-floor area are necessary.

The third door is perfectly positioned for wheelchair ramp access [ **I** ] to the wheelchair spaces—which would

necessitate buttons for deploying those ramps [ [see buttons for door opening](#) ]—and expands the open space on the middle right side of the bus [ **J** ].

## FUTURE THREE DOOR DESIGN

The ultimate three door 40 foot bus design should include a third door at the back of the bus, as is used all over Europe.<sup>39</sup>

**A rear door allows passengers to continue moving back in the bus to increase capacity, without worrying that they will not be able to alight at their stop**, removes a chokepoint, and creates a small new open space for internal passenger movement [ **K** ].

The middle door, with wheelchair ramp, should be placed directly in the middle of the bus [ **L** ], to minimize the distance passengers are from the nearest door.

Electric powered buses could more easily accommodate a third door at the back of the bus [ [see Additional & Expanded Doors](#) ].<sup>40</sup>

## STRATEGY OPTIMIZATION

Stop request buttons should be added to poles for easier access by standing riders, especially near doors where passengers with upcoming stops are more likely to stand.



*Crowded middle area and empty back aisle because riders fear being far from a door at their stop; solved with all-door boarding and a third rear door*

<sup>38</sup> [DKS Associates, "Transit Operations Analysis," Alameda County Congestion Management Agency, September 4, 2006, 7.](#)

<sup>39</sup> [Alon Levy, "Bus Bunching."](#)

<sup>40</sup> [Mercedes-Benz, "Citaro."](#)

	<b>Current Layout</b>	<b>Two Door Modifications</b>	<b>Two Door Alterations</b>	<b>Initial Three Door Design</b>	<b>Future Three Door Design</b>
Bus Layout	New Flyer Xcelsior XN40	Middle 2 Seats Removed	Middle Open Space Created	Middle Door Added	Back Door Added
Number of Seats	36	34	34	32	32
Seat Orientation	10 aisle-facing	10 aisle-facing	11 aisle-facing	9 aisle-facing	9 aisle-facing 4 backward
Number of Middle Seats	4	4	3	3	3
Number of Standees <sup>41</sup>	27	30	31	34	36
Number of Movement Chokepoints	4	4	3	3	2
Areas with Door Access only via Chokepoints	2	2	1	1	0
Open Spaces for Movement	1 small space	1 medium space	1 large space	1 large space	1 large, 1 small
Number of Doors	2	2	2	3	3

### OPPORTUNITIES & POSSIBILITIES

Explore wheelchair securement devices which allow mobility-impaired riders to secure themselves, lowering dwell times.<sup>42</sup>

## Articulated Buses

*Articulated buses will allow for higher capacity on crowded routes and will free revenue hours for increased frequency.*

### EXISTING CONDITIONS

Existing 40 foot buses see capacity problems on many routes, leading routes including the Blue and White Loops to leave passengers behind and making two buses per trip standard on the VE route and routinely necessary on other routes.

<sup>41</sup> Typical, non-crush level of crowding on CATA buses. Clive D'Souza, Victor Paquet, James Lenker, Edward Steinfeld, "Effects of transit bus interior configuration on performance of wheeled mobility users during simulated boarding and disembarking," Applied Economics 62: 94-106, DOI: 10.1016/j.apergo.2017.02.008, February 13, 2017.

<sup>42</sup> "Quantum," Q'Straint, 2019.

A completed Articulated Bus Study,<sup>43</sup> a renovated bus depot, and allocations in the Transportation Improvement Program<sup>44</sup> mean CATA can purchase and operate articulated buses.

## NEW ADVANTAGES

VE and RC services should be first to receive articulated buses, as the Articulated Bus Study recommends, and weekend V, N, and R routes could use articulated buses to reduce crowding.<sup>45</sup>

Doubled and tripper VE, RC, etc. revenue hours could be used to increase Loop service or improve V, N and R service to 30 minute headways [ see [Increased Trunk Frequency](#) ], especially on weekends.

Addition of articulated buses on some routes will free more post-2012 40 foot buses to serve Loop routes. These buses will allow for faster boarding and alighting as compared to the older 40 foot buses, which have narrower rear doors, and which operate

disproportionately on Loop routes [ see [Loops getting older buses](#) ].

## STRATEGY OPTIMIZATION

Extremely crowded White Loop buses on Friday and Saturday night<sup>46</sup> could be exchanged for articulated buses with all-door boarding [ see [Proof-of-Payment & All-Door Boarding](#) ], since they would not be in use for morning and evening peak-time crowding, but high frequencies should be retained to attract riders who might otherwise use ride-hailing apps or walk. Higher capacity would encourage more ridership because buses would be less crowded.

## OPPORTUNITIES & POSSIBILITIES

Explore the possibility of spaces or vertical racks for bikes inside articulated buses—potentially only off-peak travel, to be used as standing room at peaks—to reduce dwell time

variability due to bike loading and unloading on the front rack.

## Other Notes

Consider policies to increase capacity on existing buses:

- **Use recorded announcements and posters to encourage students to put backpacks at their feet to increase standing room on crowded buses**<sup>47</sup>
- Create recorded announcements to encourage riders to stand two people-across in wide aisles and to move to the back of the bus on crowded buses. All-door boarding [ see [Proof-of-Payment & All-Door Boarding](#) ] will help distribute riders more evenly as well
- Explore always folding up front aisle-facing seats on Loop buses and potentially other crowded routes to increase standing capacity

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<sup>43</sup> [Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization."](#)

<sup>44</sup> ["Transit Projects - Bus: Revenue Rolling Stock: Purchase - Replacement project CATA," Pennsylvania Department of Transportation, 2015.](#)

<sup>45</sup> [Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 116.](#)

<sup>46</sup> [ibid.](#)

<sup>47</sup> [Metropolitan Transportation Authority, "Take Your Pack Off Your Back," Courtesy Counts, accessed July 21, 2019.](#)



*White Loop with aisle-facing seats folded up, leaving significantly more standing capacity*

- Establish a goal to eliminate the time Loop buses spend as discharge-only, both from capacity increases and from less bus bunching,<sup>48</sup> especially from bus lanes [ [see Bus Lanes](#) ] and lower dwell times [ [see Proof-of-Payment & All-Door Boarding](#) ]

Explore electric powered buses, especially because articulated buses accelerate more slowly and use more fuel than 40 foot buses.<sup>49</sup> In-motion charging<sup>50</sup> or overhead wires—with a nearby depot, potentially near OPP [ [see second CATA depot](#) ]—might be justified on Loop routes, with potential expansion to other high-frequency routes. Battery powered buses should be considered in future bus purchases.<sup>51</sup>

Ensure future bus purchases include low windows which seated riders can look through without straining, unlike newly purchased Gillig buses. Ensure future bus purchases include middle and rear doors which slide out and to the side, like newly purchased Gillig buses and unlike New Flyer buses.



*Newly purchased Gillig bus with unfortunately high windows, necessitating riders to strain their necks to see outside, but optimal middle and rear door mechanics*

<sup>48</sup> [Alon Levy, "Bus Bunching."](#)

<sup>49</sup> [Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 2.](#)

<sup>50</sup> [Alon Levy, "In-Motion Charging," Pedestrian Observations, December 9, 2018; "Xcelsior CHARGE On-Route Charging," New Flyer, January 2019.](#)

<sup>51</sup> [Alon Levy, "Battery-Electric Buses: New Flyer," Pedestrian Observations, March 30, 2019; Alon Levy, "The Verdict's Still Out on Battery-Electric Buses," Citylab, The Atlantic Monthly Group, January 17, 2019.](#)

Bus Lanes . Atherton Transitway . Atherton Hub . Other Improvements

## **Travel Infrastructure**

Speed buses as they move through slow pedestrian-friendly corridors and congested car-oriented corridors

# Bus Lanes

*To speed buses while maintaining high pedestrian priority on campus and downtown, bus lanes should be used to remove congestion from streets with high frequency service.*

## EXISTING CONDITIONS

On campus, pedestrians are rightfully prioritized, meaning vehicles can be delayed during class changes. Cars carrying one or two people waiting for a gap in pedestrians at crosswalks cause as much delay as the buses carrying up to 80 people behind them.

Planning bus route schedules with buffers for pedestrian activity is hard, especially for Loop routes, because pedestrian levels can go from minimal to constant flow instantly at the beginning of class changes.

Roads outside campus including Atherton St, College Ave, and Beaver Ave can have significant vehicle congestion impacting bus speed and reliability.

## NEW ADVANTAGES

Bus lanes allow buses to pull into

	<b>Pattee Transit Center Eastbound [ A ]</b> Curtin Rd between Burrowes Rd and Allen Rd	<b>Pattee Transit Center Westbound [ B ]</b> Curtin Rd between Burrowes Rd and Allen Rd
Buses per hour at peak	54	23
Additional Justification	Bus lanes, without additional hundreds of cars per hour, get congested at 60 buses per hour <sup>52</sup>	
Pedestrian Crossings	High-intensity: 1 Medium-intensity: 1 Lower-intensity: 1	High-intensity: 1 Medium-intensity: 1 Lower-intensity: 1
Pedestrian-Caused Delays <sup>53</sup>	Extremely high pedestrian priority and pedestrian volumes, peaking often during class changes, lead to significant delays <sup>53</sup>	
Alternative Route for Car Traffic	Park Ave	Park Ave
Impact on Car Traffic	Minimal: <ul style="list-style-type: none"> <li>Upcoming expansion of West Campus parking will lead to less use of Park Ave</li> <li>Good alternatives including Mt Nittany Expressway and transit via Atherton St</li> </ul>	
On-street infrastructure	None	
Infrastructure using road access	Service roads with second access: 1	
Impact on infrastructure using road access	Minimal to non-existent	
Lane enforcement hours	At least all day weekdays	
Permitted vehicles, plus CATA buses & emergency vehicles	Service vehicles at night, non-CATA PSU buses	
Priority for Implementation	1	2
Rational for Priority	<ul style="list-style-type: none"> <li>Extremely high number of buses per hour</li> <li>Lack of infrastructure dependent on road access</li> <li>Implementation would reduce traffic on the rest of Curtin Rd before a full bus lane</li> </ul>	<ul style="list-style-type: none"> <li>High number of buses per hour</li> <li>Mirroring the eastbound bus lane reduces confusion for car drivers</li> <li>Lack of infrastructure dependent on road access</li> </ul>
Short-term solution	Implement bus lanes with signage and road paint and implement enforcement measures	
Long-term solution	<b>Buildings with abundant and large classrooms should be located closer to transit stops to allow for easy access to transit for more people.</b>	

traffic from bus pull-offs without being slowed by passing mixed-traffic. Bus lanes almost eliminate the possibility of vehicles using bus pull-offs and interrupting buses.

## STRATEGY OPTIMIZATION

Initial bus lane projects should begin as temporary pilots [ [see Implementation](#) ] to expedite implementation, allow for alterations, and ease opposition.



*A Blue Loop behind a line of cars waiting at the pedestrian crossing before Pattee Transit Center*

	<b>Curtin Rd Eastbound [ C ]</b> between Allen Rd and Bigler Rd	<b>Curtin Rd Westbound [ D ]</b> between Allen Rd and Bigler Rd
Buses per hour at peak	39	23
Additional Justification	10% of travel time is spent stopped in traffic and at intersections on campus during reduced service and off-peak, higher at peak times and during full service <sup>54</sup>	
Pedestrian Crossings	High-intensity: 1 Medium-intensity: 6 Lower-intensity: 3	High-intensity: 1 Medium-intensity: 6 Lower-intensity: 3
Pedestrian-Caused Delays <sup>53</sup>	Extremely high pedestrian priority and pedestrian volumes, peaking often during class changes, lead to significant delays <sup>53</sup>	
Alternative Route for Car Traffic	Park Ave Eisenhower Rd	Park Ave Eisenhower Rd
Impact on Car Traffic	Minimal: <ul style="list-style-type: none"> <li>Upcoming expansion of West Campus parking will lead to less use of Park Ave</li> <li>Good alternatives including Mt Nittany Expressway and transit via Atherton St</li> </ul>	
On-street infrastructure	On-street handicapped parking spaces: 6 On-street 15 min parking spaces: 4	Non-CATA bus pull-offs: 1
Infrastructure using road access	Service/parking areas without second access: 3 Parking lots without second access: 3	
Impact on infrastructure using road access	Low, especially because local traffic would be allowed until parking lots are phased out of central campus	
Lane enforcement hours	All day weekdays	
Permitted vehicles, plus CATA buses & emergency vehicles	Local traffic (until all parking spaces are removed) and service vehicles, non-CATA PSU buses	
Priority for Implementation	3	4
Rational for Priority	<ul style="list-style-type: none"> <li>Very high number of buses per hour</li> </ul>	<ul style="list-style-type: none"> <li>High number of buses per hour</li> <li>Mirroring the eastbound bus lane reduces confusion for car drivers</li> </ul>
Short-term solution	Expand the bus lanes at Pattee Transit Center along Curtin Rd	
Long-term solution	Phase out on-street and off-street parking in favor of dense development, creating more potential transit riders and reducing local vehicular traffic, until all vehicles except for service can be removed. <b>Buildings with abundant and large classrooms should be located closer to transit stops to allow for easy access to transit for more people.</b>	

# Atherton St and Curtin Rd via Eastbound Pattee Transit Center

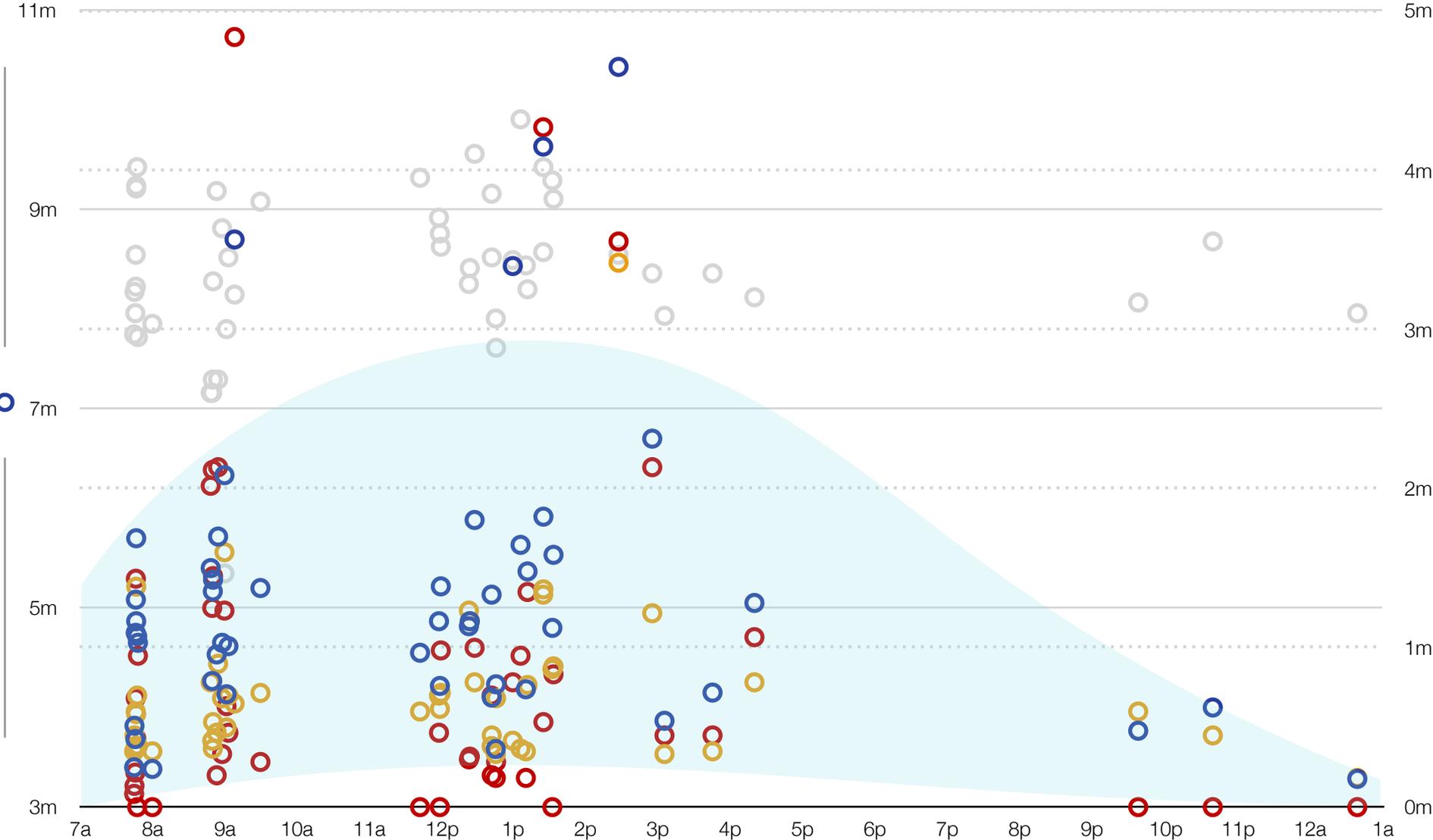
Blue Loop and Green Link from Walker Building to Pavilion Theatre<sup>55</sup>

**Overall travel time** is generally higher morning to evening on weekdays in full service

**Time spent moving** stays generally constant all the time

**Time stopped at intersections and in traffic** sees significantly **increased variability** morning to evening on weekdays in full service

**Time at bus stops** is generally higher morning to evening on weekdays in full service



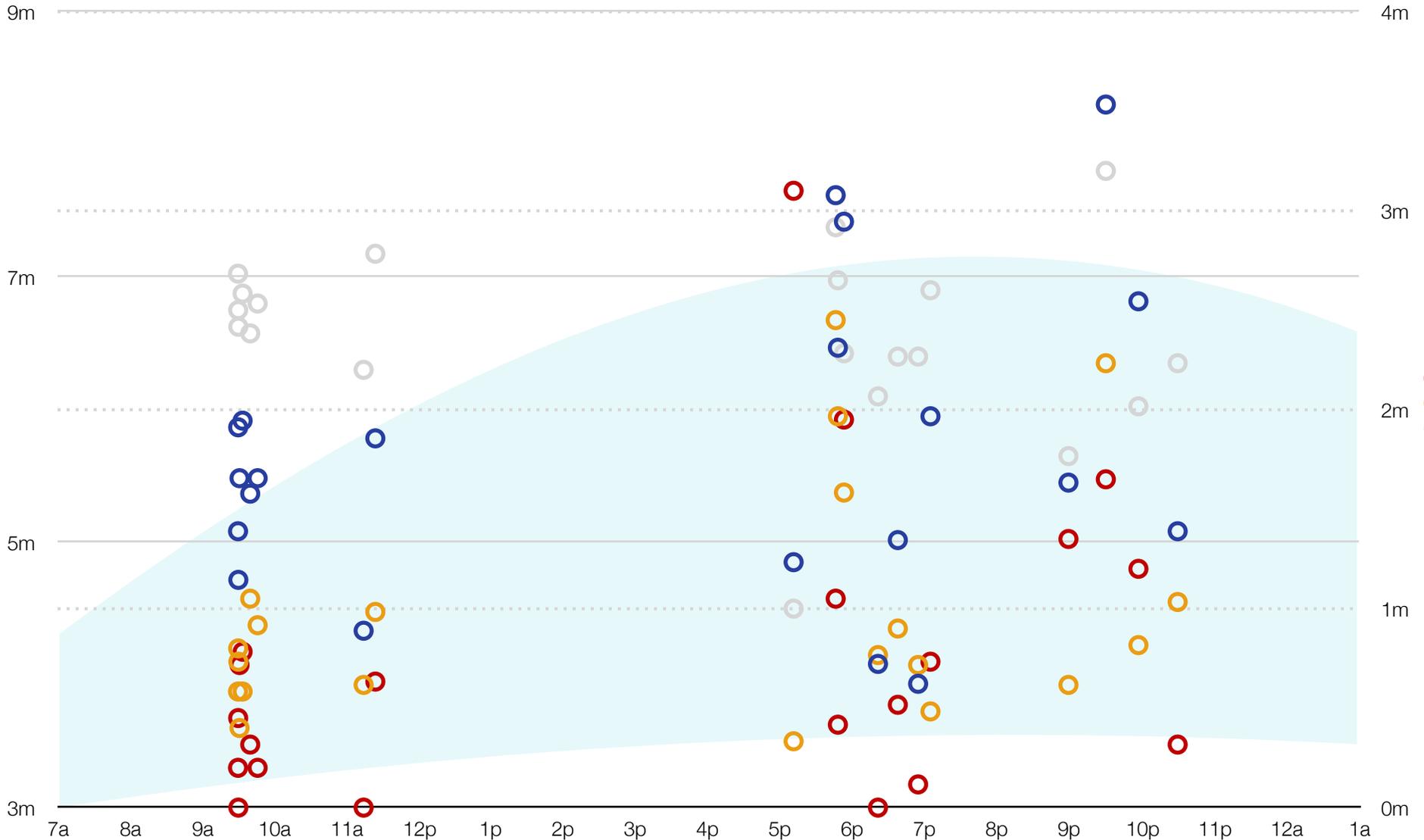
# Curtin Rd and Burrowes Rd via Westbound Pattee Transit Center

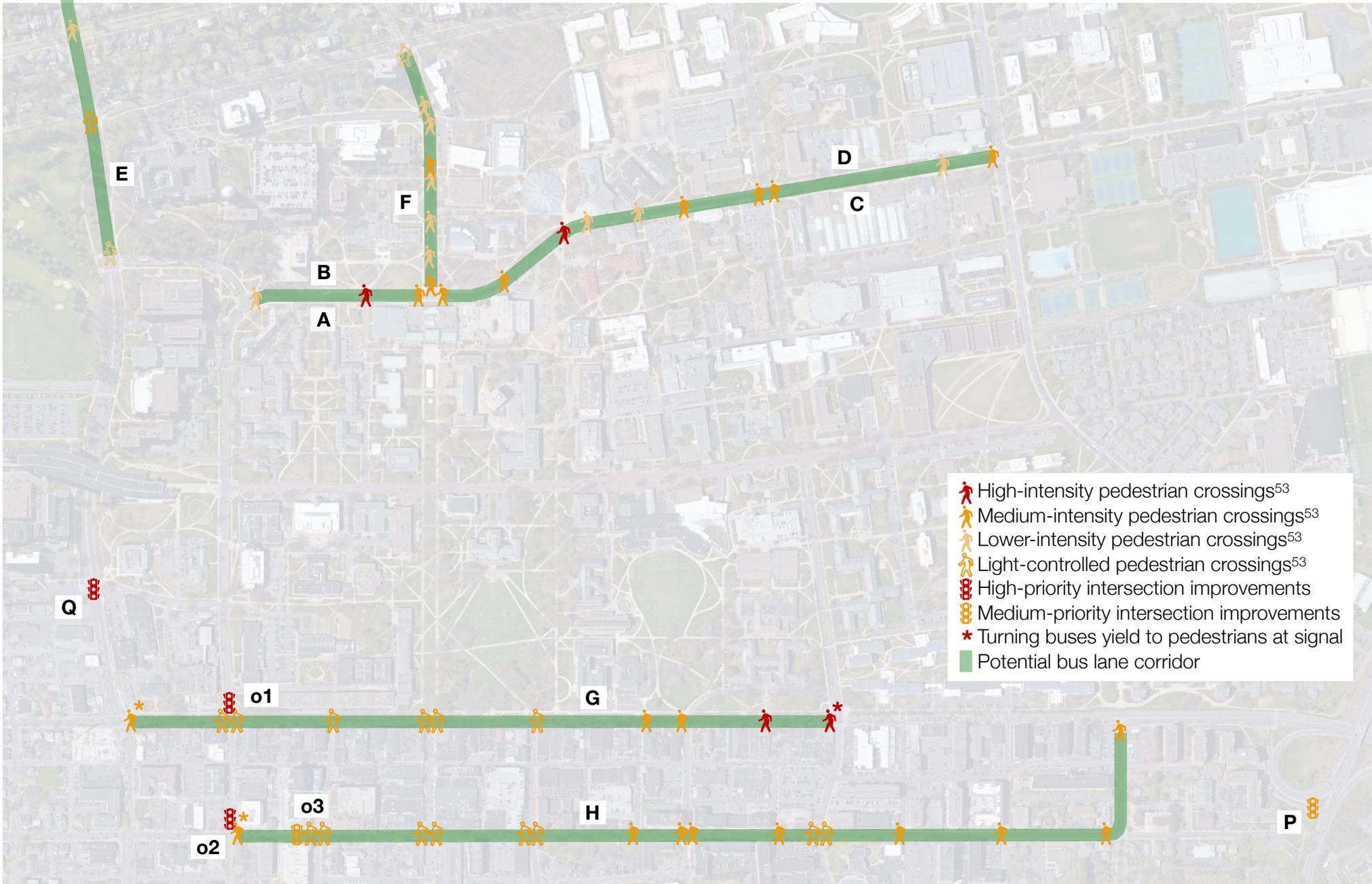
White Loop from Visual Arts Building to Elliott Building<sup>55</sup>

**Overall travel time, time stopped at intersections and in traffic, time at bus stops** are **generally higher** and see significantly **increased variability** afternoon to night on weekdays in full service

**Time spent moving** stays **generally constant** but sees **increased variability** afternoon to night on weekdays in full service

\*outlier not shown: 18 minute overall trip time



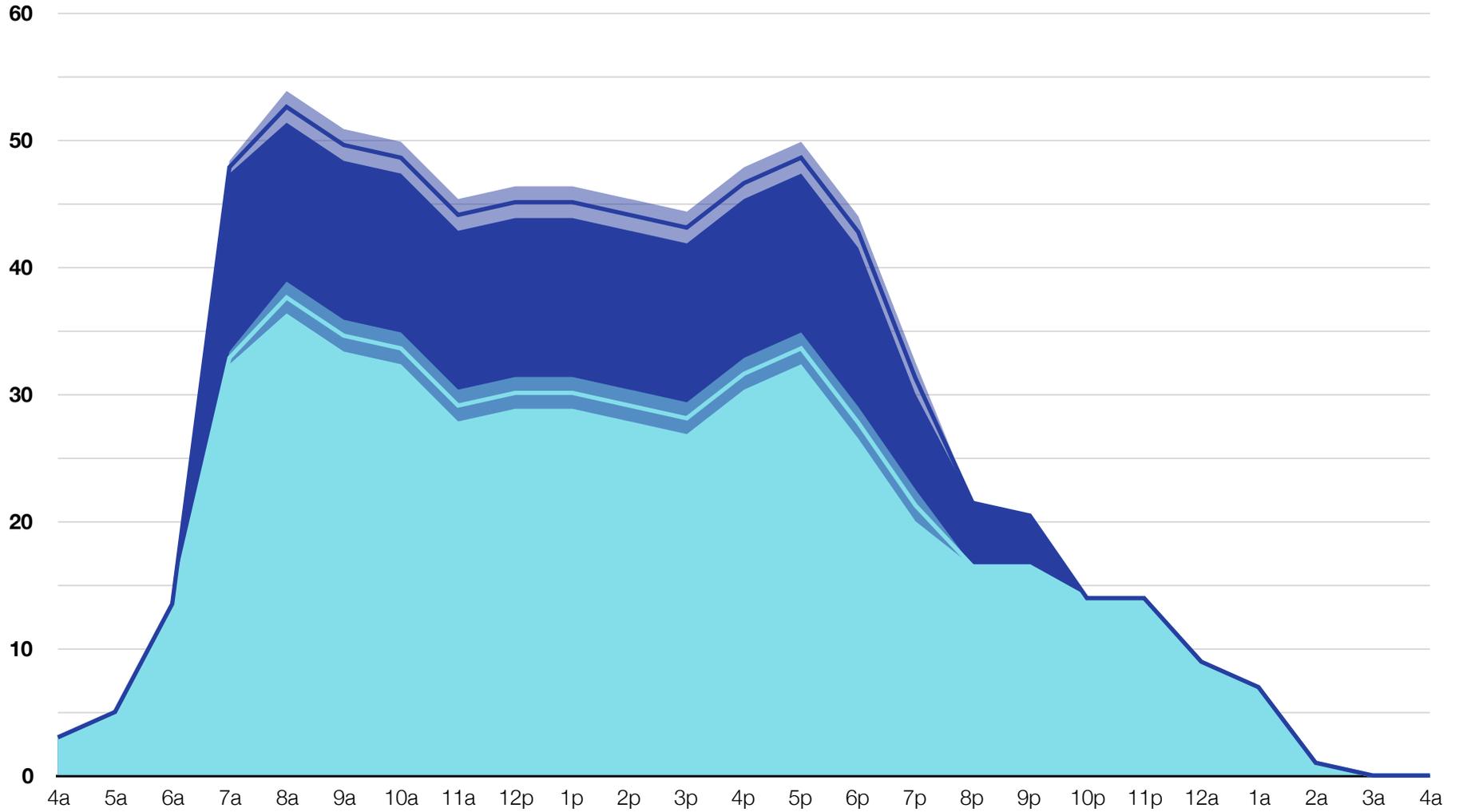


42 Potential bus lanes and major pedestrian and signal congestion points

**Number of Buses per Hour**  
Friday during full service<sup>55</sup>

Max: **54** buses per hour  
**Eastbound Pattee Transit Center**

Max: **39** buses per hour  
**Eastbound Curtin Rd at Shortlidge Rd**



**Number of Buses per Hour**  
Friday during full service<sup>55</sup>

Max: **23** buses per hour

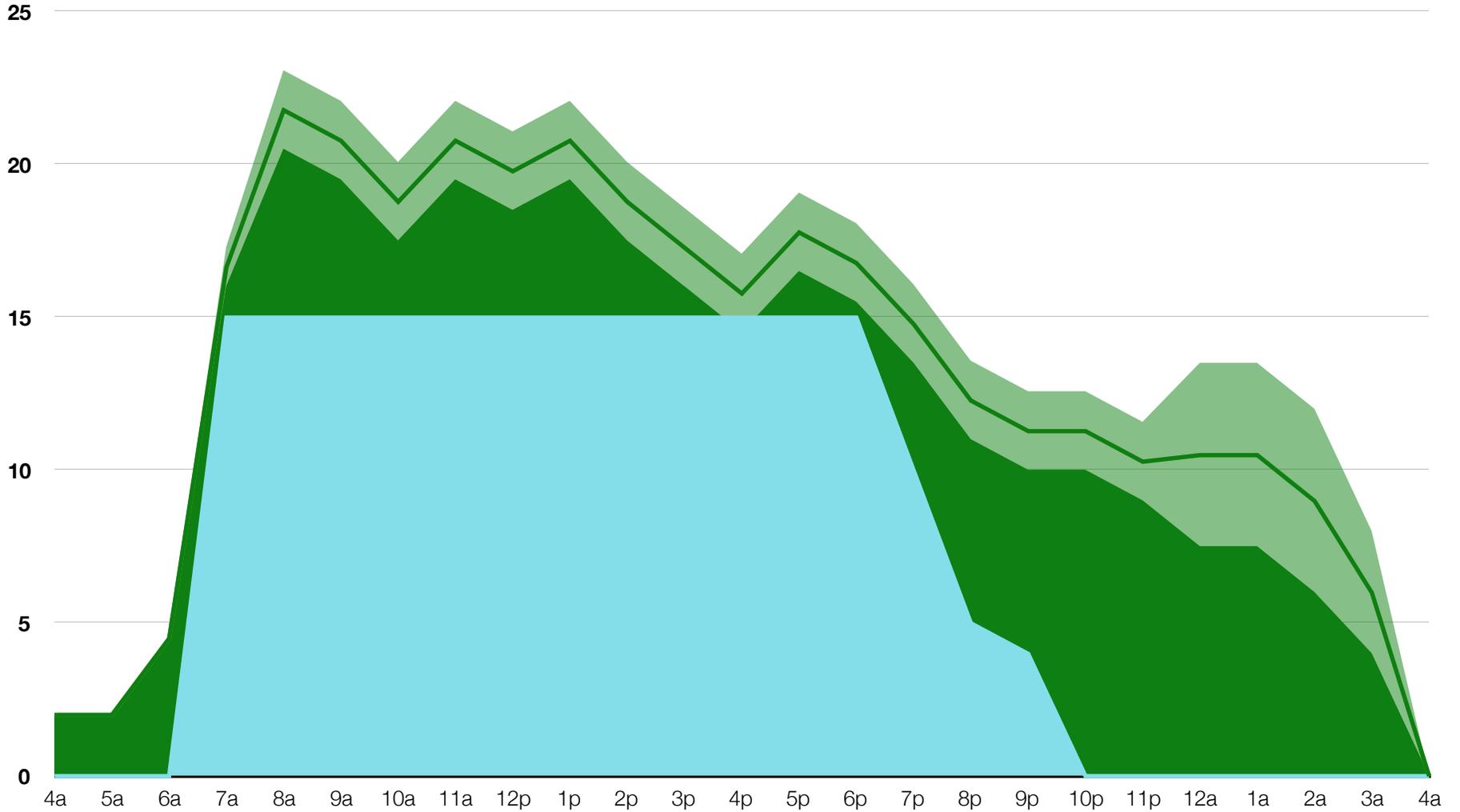
**Westbound Pattee Transit Center**

Max: **23** buses per hour

**Westbound Curtin Rd at Shortlidge Rd**

Max: **15** buses per hour

**Allen Rd at Park Ave Northbound**

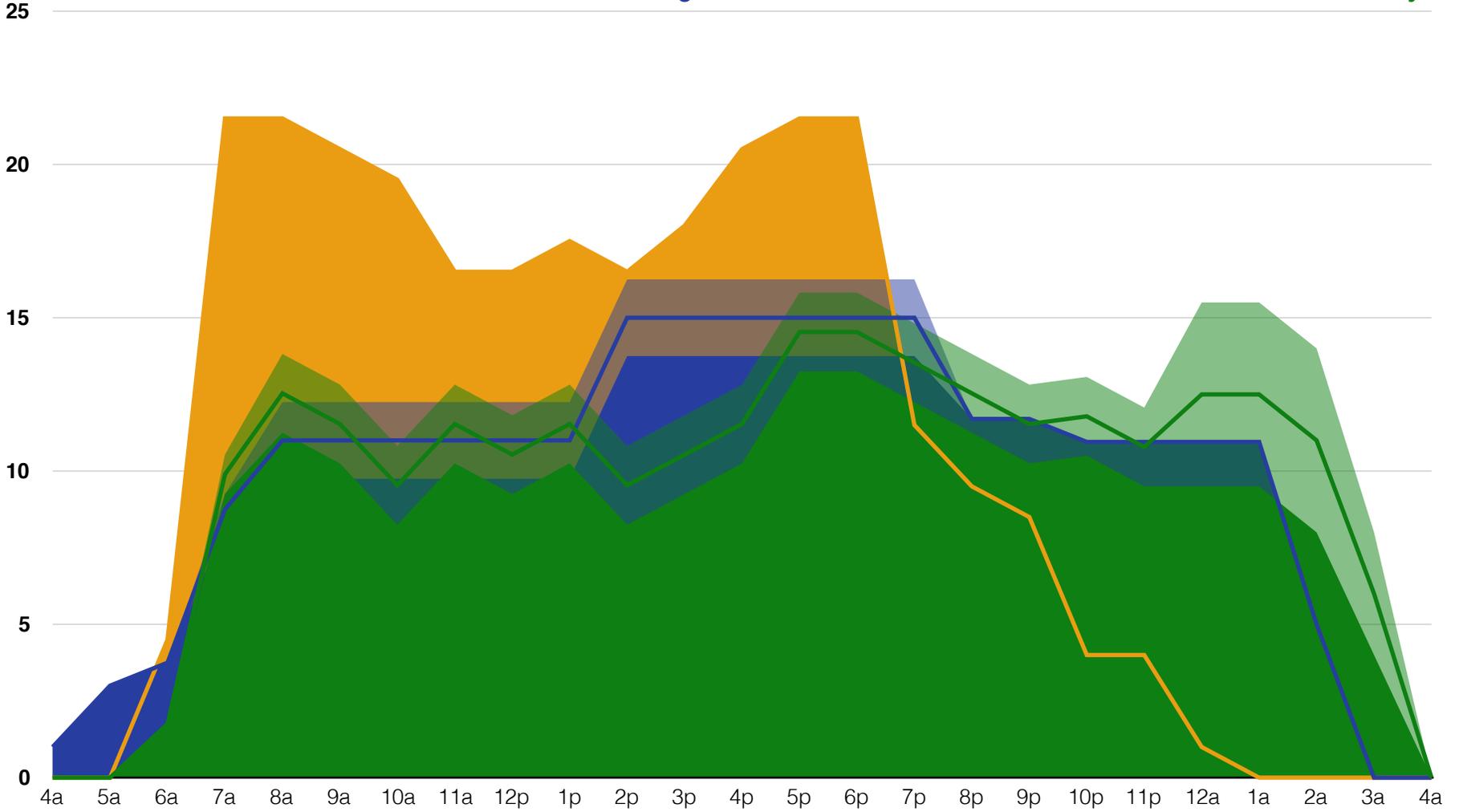


**Number of Buses per Hour**  
Friday during full service<sup>55</sup>

Max: **22** buses per hour per direction  
**Atherton St at Hillcrest Ave**

Max: **16** buses per hour  
**College Ave and Allen St**

Max: **16** buses per hour  
**Beaver Ave at Schlow Library**



## COMPARISON: NEW YORK CITY BUS LANES, NUMBER OF BUSES PER HOUR

	7-8a <sup>57</sup> each direction	9-10a <sup>57</sup> each direction	11a-12p <sup>57</sup> each direction	Current Street Configuration <sup>58</sup> each direction unless noted: 'shared'	Additional Information
<b>125th St, Manhattan</b>	M60 +SBS: 7	M60 +SBS: 6	M60 +SBS: 6		
	M101 ltd: 5	M101 ltd: 10	M101 ltd: 7	1 travel lane	Before bus lane treatment: <sup>59</sup>
	M100: 8	M100: 6	M100: 6	1 bus lane	2 travel lanes
	Bx15 ltd: 7	Bx15 ltd: 7	Bx15 ltd: 5	1 parking and bus pull-off lane	1 parking lane
	<b>Total: 27</b>	<b>Total: 29</b>	<b>Total: 24</b>		
<b>23rd St, Manhattan</b>	M23 +SBS: 7	M23 +SBS: 7	M23 +SBS: 7	1 travel lane	
	<b>Total: 7</b>	<b>Total: 7</b>	<b>Total: 7</b>	1 bus lane	
				1 shared parking, bus bulb-out, right and left turn lane	
<b>34th St, Manhattan</b>	M34 +SBS: 3	M34 +SBS: 7	M34 +SBS: 4	1 travel lane	<b>Proposed transitway:<sup>60</sup></b>
	M34A +SBS: 4	M34A +SBS: 6	M34A +SBS: 5	1 bus lane	1 travel lane
	<b>Total: 7</b>	<b>Total: 13</b>	<b>Total: 9</b>	1 shared parking, bus bulb-out, right and left turn lane	1 bus lane 1 shared parking, bus bulb-out, and median platform lane
<b>1st and 2nd Aves, Manhattan</b>	M15: 7	M15: 7	M15: 6	3 travel lanes	
	M15 +SBS: 24	M15 +SBS: 8	M15 +SBS: 8	1 bus lane	
	<b>Total: 31</b>	<b>Total: 15</b>	<b>Total: 14</b>	2 parking/turning lanes on 1 <sup>st</sup> Ave 1 parking/turning lane on 2 <sup>nd</sup> Ave 1 protected bike lane	
<b>Fulton St Transit Mall, Brooklyn</b>	B38 local: 8	B38 local: 10	B38 local: 6		
	B38 ltd: 6	B38 ltd: 8	B38 ltd: 6		
	B52: 9	B52: 8	B52: 6		
	B25: 4	B25: 6	B25: 6	2 transit lanes with local traffic	
	B26: 6	B26: 7	B26: 5		
	<b>Total: 33</b>	<b>Total: 39</b>	<b>Total: 29</b>		
<b>E Fordham Rd, Bronx</b>	Bx12: 6	Bx12: 5	Bx12: 5		
	Bx12 +SBS: 17	Bx12 +SBS: 10	Bx12 +SBS: 10		
	Bx9: 14	Bx9: 7	Bx9: 5		
	Bx17: 11	Bx17: 6	Bx17: 5		
	Bx22: 9	Bx22: 7	Bx22: 5		
	B-L 60: 4	B-L 60: 2	B-L 60: 2	2 travel lanes	<b>One of the best potential light rail routes in New York<sup>61</sup></b>
	B-L 61: 2	B-L 61: 1	B-L 61: 2	1 bus lane	
	B-L 62: 1	B-L 62: 0	B-L 62: 0	1 intermittent shared left turn lane	
<b>Total: 64</b>	<b>Total: 38</b>	<b>Total: 34</b>			
<b>W Fordham Rd, Bronx</b>	Bx12: 6	Bx12: 5	Bx12: 5		
	Bx12 +SBS: 17	Bx12 +SBS: 10	Bx12 +SBS: 10		
	<b>Total: 23</b>	<b>Total: 15</b>	<b>Total: 15</b>		
<b>Utica Ave, Brooklyn</b>	B46: 17	B46: 7	B46: 6	1 travel lane	<b>One of highest priority subway extensions in New York<sup>62</sup></b>
	B46 +SBS: 25	B46 +SBS: 11	B46 +SBS: 10	1 bus lane	Before bus lane treatment: <sup>63</sup>
	<b>Total: 42</b>	<b>Total: 18</b>	<b>Total: 16</b>	2 shared parking and turning lanes	2 travel lanes 1 parking lane

**Atherton St (both directions) [ E ]**  
between Curtin Rd and Blue Course Dr

**Allen Rd Northbound [ F ]**  
between Curtin Rd and Park Ave

Buses per hour at peak	22 (each direction)	15
Pedestrian Crossings	Lower-intensity: 4 Traffic light-controlled: 7	Medium-intensity: 1 Lower-intensity: 5 Traffic light-controlled: 1
Pedestrian-Caused Delays <sup>53</sup>	Low pedestrian volumes, signalized crossings, and high vehicle priority lead to almost no pedestrian-caused delays <sup>53</sup>	Low pedestrian and vehicle volumes lead to few pedestrian-caused delays <sup>53</sup>
Annual Average Daily Traffic <sup>64</sup>	E: 18,879 / W: 20,952	
Alternative Route for Car Traffic	Number of traffic lanes reduced	Atherton St, Shortlidge Rd
Impact on Car Traffic	Medium: <ul style="list-style-type: none"> <li>Construction on Atherton St shows two lanes on Atherton St is manageable but creates congestion in the short term<sup>65</sup></li> <li>Stopping buses—which currently slow traffic and encourage unsafe merging—would be removed from mixed-traffic lanes</li> <li>Alternative routes and good transit alternatives will limit disturbance once existing car drivers adjust</li> </ul>	Minimal: high unused capacity on alternatives and low traffic volumes; especially if Curtin Rd is already bus-only
Infrastructure using road access	Cross streets: 10 Driveways: 25 Business entrances: 20	Service areas: 2
Impact on infrastructure using road access	Cross streets: non-existent; all turning movements are maintained Driveways and business entrances: medium; most become right-in/right-out which comes with traffic and safety benefits	Minimal to non-existent
Lane enforcement hours	Rush hours while curbside lanes, all times when median-running transitway	All day weekdays while PSU is in session
Permitted vehicles, plus CATA buses & emergency vehicles	Curbside lanes: HOV 2+ or 3+ Median-running transitway: intercity buses	Service vehicles at night
Priority for Implementation	6	8
Rational for Priority	<ul style="list-style-type: none"> <li>Higher potential community opposition and higher capital cost</li> <li>High potential for improving CATA in rider and public consciousness</li> <li>Potential for expansion into BRT-like route on Atherton St</li> </ul>	<ul style="list-style-type: none"> <li>High number of buses per hour</li> <li>Low congestion, but low impact to car drivers</li> <li>Future: obsolete [ <a href="#">see Interlined Adjunct Route Network</a> ]</li> </ul>
Short-term solution	Explore increasing transit visibility through better stops with shelters and painted transit and HOV 2+ or 3+ curbside lanes	Continue bus lane rollout from Curtin Rd to Park Ave
Long-term solution	[ <a href="#">see Atherton Transitway</a> ]	Determine optimal treatment on Park Ave westbound: <ul style="list-style-type: none"> <li><b>Explore pre-signals to speed buses without taking mixed-traffic lanes<sup>66</sup></b></li> <li>Any Park Ave widening should include bus lanes and no additional mixed-traffic lanes, except potentially on football gamedays</li> </ul>

**College Ave [ G ]**  
between Shortlidge Rd/Garner St and Atherton St

**Beaver Ave [ H ]**  
between Burrowes St and into High St to College Ave

Buses per hour at peak	16	16
Additional Justification	10% of travel time is spent stopped in traffic and at intersections downtown during reduced service and off-peak, higher at peak times and during full service <sup>54</sup>	
Pedestrian Crossings	High-intensity: 2 Medium-intensity: 3 Traffic light-controlled: 6	Medium-intensity: 9 Traffic light-controlled: 8
Pedestrian-Caused Delays <sup>53</sup>	Signalized crossings remove most pedestrian-caused delays, leading to delays only at a small number of crossings <sup>53</sup>	High pedestrian volumes but high vehicle priority lead to few pedestrian-caused delays <sup>53</sup>
Annual Average Daily Traffic <sup>64</sup>	11,164	8,595
Alternative Route for Car Traffic	Number of traffic lanes reduced	Number of traffic lanes reduced
Impact on Car Traffic	Medium: College Ave is already congested at peaks because of traffic lights, and reducing the number of traffic lanes will maintain that congestion, <sup>65</sup> but bus lanes will offer a better alternative	Low: Low traffic volumes can be supported by fewer lanes
On-street infrastructure	On-street parking spaces: 123 <sup>67</sup> On-street loading zones: 7 On-street theater/church pull-off zones: 3	On-street parking spaces: 40 <sup>67</sup> On-street loading zones: 7
Infrastructure using road access	Cross streets: 9 Downtown service entrances: 1 Downtown private parking lots: 1 Campus service and parking: 1 Campus parking lots/loading accessible by cross street or second entrance: 3	Cross streets: 11 Cross alleys: 6 Loading/drop-off entrances: 1 Public off-street parking: lots with second entrances: 2 garages with second entrances: 1 Private off-street parking: lots without second entrances: 5 lots with second entrances: 5 garages without second entrances: 1 garages with second entrances: 1 driveways: 7
Impact on infrastructure using road access	Medium: local traffic would need access; although limiting car traffic downtown would have other character and safety benefits	
Lane enforcement hours	All day weekdays	
Permitted vehicles, plus CATA buses & emergency vehicles	Short term: local traffic and loading vehicles Long term: local traffic and loading vehicles at night	
Priority for Implementation	5	7
Rational for Priority	<ul style="list-style-type: none"> <li>• High congestion during peak times</li> <li>• Higher potential community opposition</li> </ul>	<ul style="list-style-type: none"> <li>• High number of buses per hour</li> <li>• Higher potential community opposition</li> <li>• Significant amount of infrastructure dependent on road access</li> </ul>

## College Ave and Beaver Ave Continued

- Short-term solution
- Implement transit signal priority on College Ave, Burrowes St, and Beaver Ave through downtown [ [see Transit Signal Priority](#) ]
  - Implement strategies to encourage car drivers to yield to buses pulling out of bus stops [ [see priority merge rule](#) ]
  - Explore implementation of curbside bus lanes, with special consideration to limit impacts of parallel parking on bus speed
- Further study should determine whether creating one bus-only two way street and one mixed-traffic two way street is warranted.
- Beaver Ave transitway benefits:
- potential for significantly more residential, retail commercial, and office commercial density than College Ave with redevelopment due to zoning
  - more useful for White Loop picking up passengers from apartments south of downtown
  - creates significantly fewer dead-end cross streets
- Long-term solution
- College Ave transitway benefits:
- most cross streets are three way intersections: only pedestrians, no vehicles, cross bus lanes
  - currently the commercial core of downtown and closer to campus
  - more pedestrian traffic
  - connects to campus to create larger almost-car-free area
  - dead-end cross streets can have car access at Calder Alley and many pedestrian plazas are created between Calder Alley and College Ave

<sup>52</sup> [Jarrett Walker, "Minneapolis: Unlocking Downtown with Transit Malls," Human Transit, November 23, 2009.](#)

<sup>53</sup> **[High pedestrian priority is good for walkable, urban places and should be encouraged, even if it slows buses. Removing vehicles with bus-only or HOV lanes maintains pedestrian priority and increases transit priority, by ensuring each vehicle passing a crosswalk is carrying 40 or more people, rather than one or two.](#)**

<sup>54</sup> Overall trip time average between Pattee Transit Center and College Ave at Allen St is 8:26; average 49 seconds stopped in traffic and at intersections; 9.6% of travel time spent stopped. All data collected during reduced service, late night, or on weekends; times with higher pedestrian levels would probably see higher percentage of travel time stopped. See [appendix](#) for raw data.

<sup>55</sup> See [appendix](#) for raw data.

<sup>56</sup> Lighter ranges indicate variation based on Blue and White Loop service. See [appendix](#) for raw data.

<sup>57</sup> ["New York City Bus Schedules," Schedules, Metropolitan Transportation Authority, June 30, 2019.](#)

<sup>58</sup> [Google Maps](#)

<sup>59</sup> ["M60 Select Bus Service on 125th Street," Community Board 9 Update, New York City Transit, June 5, 2013.](#)

<sup>60</sup> Transitway canceled because of opposition to losing curbside loading and parking, which N Atherton St does not have. ["34th Street Transitway," New York City Transit, May 3, 2010; URS Corporation, AKRF, Inc.; & Zetlin Strategic Communications, "34th Street Transit Corridor: Alternatives Analysis Screening Report," New York City Department of Transportation, February 2010.](#)

<sup>61</sup> [Alon Levy, "De Blasio Versus Good Transit," Pedestrian Observations, February 29, 2016.](#)

<sup>62</sup> [Amy Plitt, "Utica Avenue Subway Extension to be Studied, Again," Curbed New York, Vox Media, Inc., April 8, 2019.](#)

<sup>63</sup> ["Utica Avenue Select Bus Service," New York City Department of Transportation, 2015.](#)

Effective enforcement of bus lanes is necessary for meaningful increases in bus speed and reliability. **All buses should be equipped with bus-mounted enforcement cameras to automatically enforce bus lanes.**<sup>68</sup>

Bus lanes next to mixed-traffic lanes should use flexible bollards or other separators to keep vehicles from switching lanes into the bus lane. Gates should be avoided, unless they cause zero delay to buses, but might be necessary in places like Curtin Rd until local traffic can be eliminated.

## OPPORTUNITIES & POSSIBILITIES

Use bus-mounted enforcement cameras to fine unauthorized vehicles using bus pull-offs. Eventually, all bus pull-offs on campus should be adjacent to bus lanes, and bus pull-offs off campus should be retired in favor of bus stop bulb-outs and curbside stops [ see optimal condition bus stops ], so enforcement will not be an issue.

Explore removal of stop signs along bus lanes on campus if there are no significant impacts to pedestrian movement.



*One of many unauthorized vehicles parking in high-use bus pull-offs*

# Atherton Transitway

*Create a median transitway along N Atherton St to improve bus speeds and market bus service as rapid transit-like.*

## EXISTING CONDITIONS

V, N, W, A, and G buses pass close to central campus outbound, over 15 minutes after they stop at Pattee Transit Center, but can't pick up passengers because there is no stop north of Walker Building on Atherton St, wasting rider time and suppressing ridership.

Stopped buses on Atherton St disturb traffic flow and encourage unsafe merges which could lead to political support for bus pull-offs,<sup>69</sup> slowing

<sup>64</sup> [Pennsylvania Department of Transportation, "Pennsylvania Traffic Counts," Pennsylvania Spatial Data Access, May 2019.](#)

<sup>65</sup> [Todd Litman, "Generated Traffic and Induced Travel: Implications for Transport Planning," Victoria Transport Policy Institute, March 18, 2019.](#)

<sup>66</sup> [Laura Bliss, "When is a Dedicated Bus Lane Not a Dedicated Bus Lane?" CityLab, The Atlantic Monthly Group, May 31, 2018.](#)

<sup>67</sup> [Mahan Rykiel Associates Inc., "State College Downtown Master Plan," State College Borough, August 19, 2013.](#)

<sup>68</sup> [Richard Roisman, "Bus Lane Enforcement Study," National Capital Region Transportation Planning Board, June 2017.](#)

<sup>69</sup> [Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 122.](#)

buses significantly [ [see optimal condition bus stops](#) ].

N and W routes are unable to stop with V buses on Atherton St at Blue Course Dr because they must turn left, while the existing bus stop is on the right side of the street.

Buses currently transport 30 percent of travelers on Atherton St, but have no dedicated right of way.<sup>70</sup>

All routes traveling on N Atherton St have on-time performance below 90 percent:

On-Time Performance:  
Routes on N Atherton St<sup>71</sup>

<b>A</b>	71.1%
<b>G</b>	78.4%
<b>N</b>	85.2%
<b>NE</b>	82.6%
<b>V</b>	83.7%
<b>VE</b>	81.3%
<b>W</b>	78.8%
<b>WE</b>	88.5%

## NEW ADVANTAGES

Inbound/outbound stations are paired and are generally spaced about 1/4 mile apart—the international standard<sup>72</sup>—from each other and from stops on Atherton St in both directions past the transitway. Stops are slightly farther apart in less dense single family-zoned areas with little development potential [ [i1](#) ] and are closer together in more dense and destination-rich campus and downtown [ [i2](#) ].

To maintain left-turn lanes, stations are generally mid-block between major intersections. Infrequent major cross



*Five buses stalled in traffic on N Atherton St at W Mitchell Ave on Oct 20, 2018*

streets mean all intersections must allow for left turns, removing the possibility of every other major intersection hosting platforms rather than left turn lanes. The mid-block northbound platform at Rec Hall allows buses turning onto Curtin Rd to merge into the mixed-traffic lane between the platform and the Curtin Rd intersection [ [J](#) ].

All left turning lanes to public streets are maintained at their current lengths, including left turns to Village Dr. Almost all driveways are converted to right-in, right-out onto Atherton St, improving safety. Most parking lots have access from secondary streets, allowing for left turning traffic without u-turns.

Mid-block crossings are necessary because most stations are not at intersections. Crosswalks only require crossing one mixed-traffic lane and/or two transit lanes at a time rather than five mixed traffic lanes—where car drivers might be distracted by changing lanes—improving pedestrian safety. Often stations are close to— or intersect with intersections of smaller roads or major commercial driveways, so many crosswalks help pedestrians not using transit as well.

<sup>70</sup> Centre Area Transportation Authority, “Assessment of Articulated Bus Utilization,” 122.

<sup>71</sup> [ibid.](#), 20-94.

<sup>72</sup> Alon Levy, “Stop Spacing and Route Spacing,” [Pedestrian Observations](#), April 21, 2019.



- █ Transit lane
- █ Bus platform
- █ Mixed-traffic lane
- Left-turn lane
- New crosswalk/sidewalk

**Cherry Lane**

**1700 ft or .32 mi**  
between Cherry and Hillcrest

**Hillcrest Ave**

**1600 ft or .30 mi**  
between Hillcrest and Rec Hall

**M**

**i1**

Hillcrest Ave

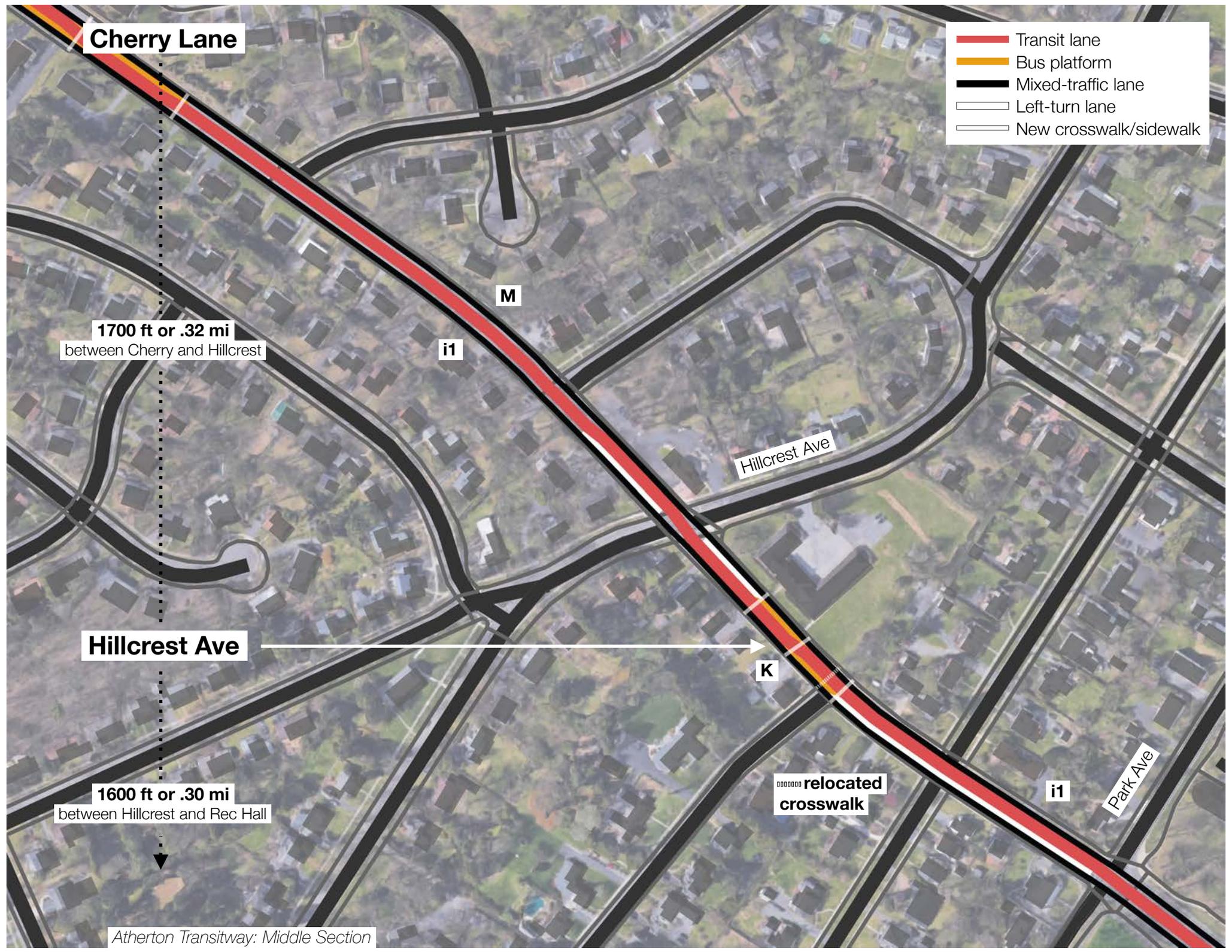
**K**

**relocated crosswalk**

**i1**

Park Ave

*Atherton Transitway: Middle Section*



-  Transit lane
-  Bus platform
-  Mixed-traffic lane
-  Left-turn lane
-  New crosswalk/sidewalk

**1600 ft or .30 mi**  
between Hillcrest Ave and Rec Hall

**Rec Hall**

**1000 ft or .19 mi**  
between Rec Hall and Westgate

**Westgate Building**

**1300 ft or .25 mi**  
to next stops on Atherton St

*Atherton Transitway: Southern Section*

Curtin Rd

White Course Dr

J

L

L

i2



As commercial lots are redeveloped as dense, walkable, and mixed use, the parking lot access points could become roads, but these roads would have no left turn access because vehicular traffic would not be as important as pedestrian traffic on these walkable streets. Roads specifically adjacent to station platforms should be extended because they allow pedestrians to walk as far as possible from the station in the shortest amount of time, increasing the effective walkshed of these stations. Pedestrian and shared-use paths can substitute for roads initially because almost all transit riders will walk or bike to the stations.

All stations have space for one articulated 60 foot bus and one 40 foot bus to stop simultaneously.<sup>73</sup> All stations have at least 140 foot full-width platforms except at Hillcrest Ave [ **K** ], which has 100 foot full-width platforms and 140 foot platforms including thinner wedge-shaped platform areas. Hillcrest Ave is the station with the least development potential because of surrounding single-family zoning and therefore the least ridership potential so it can expect fewer buses to stop with less dwell time than other stops on the corridor in the future.

Loss of mixed-traffic lanes would be offset by cars no longer being stopped by buses at bus stops, and buses would not be delayed by pulling back into traffic from potential bus pull-offs.

## STRATEGY OPTIMIZATION

The transitway could be implemented temporarily as a pilot program [ [see Implementation](#) ], using paint and movable protective barriers.

Transit lanes should be separated from mixed-traffic lanes by flexible bollards, and later curbs, so transit lanes cannot be merged into by other vehicles.

Transitway lane widths are 11 feet wide, mixed-traffic lanes are 10 feet wide, and left turn lanes and platforms are 9 feet wide,<sup>74</sup> allowing for a 51 foot wide cartway, necessitating no curb reconstruction. Where no station platforms or left turn lanes are necessary, medians can separate mixed-traffic lanes from bus lanes, or the road can be narrowed to allow for wider sidewalks [ **M** ]. Stations and medians could be widened where the road is wider than 51 feet. Mixed-traffic lanes should not be widened to keep speeds low, increasing pedestrian and vehicle safety.

Stops on campus should include additional pedestrian infrastructure to allow for easier access. A corridor through Rec Hall directly from the center of campus to the Rec Hall station [ **L** ] should be unlocked at all times to allow for faster access to the station and to create a heated shelter space.

Southbound past Curtin Rd, the transit lane would only carry the Red Link and RC routes and could be built later, but should be built to allow the RC to stop on Atherton St, to increase consistency for car drivers, to allow for future services through downtown serving only Atherton St [ [see Interlined Adjunct Route Network](#) ], and to allow for potential White Loop service on Atherton St with the conversion of College Ave or Beaver Ave to a transitway [ [see Bus Lanes](#) ].

Stations on campus are named after buildings—Rec Hall and Westgate Building—which face Atherton St but are associated more with Burrowes Rd, so riders consider the stations being as close as possible to the center of campus.

**A median transitway greatly increases the visibility of frequent transit to car drivers, potentially**

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<sup>73</sup> “Bus Rapid Transit Service Design Guidelines.” VTA Transit Sustainability Policy 2007, VTA Transit, 2007, 78.

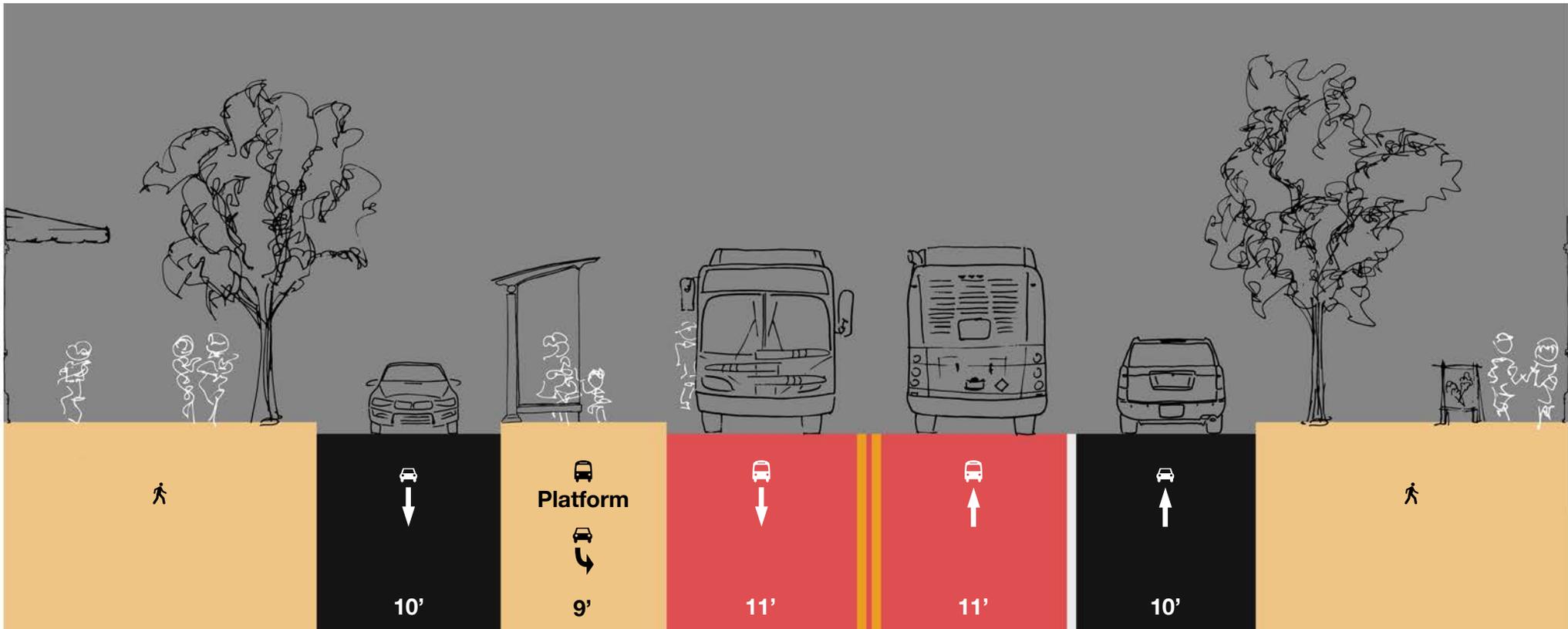
<sup>74</sup> “In-Street Boarding Island Stop,” Transit Street Design Guide, National Association of City Transportation Officials, April 2016.

leading to more decisions to take transit, just as advertisers hope exposure to their brand will lead to higher sales. Stops are called stations rather than bus stops to impress the idea of rapid, frequent transit like subways provide.

### OPPORTUNITIES & POSSIBILITIES

With increased political support, stations could be moved closer to major intersections to reduce walking and cycling time to destinations far from Atherton St and to allow for future transfer opportunities with perpendicular routes.

The transitway should be continued through and past downtown as political support allows, with special effort given to connect the transitway to a future transitway on College Ave or Beaver Ave. Westgate Building Station could be moved closer to College Ave with an extended transitway, to standardize inter-station distance and to better serve downtown. Innovative solutions



Atherton Transitway: Section at Station Platform

or significantly more political support will be necessary to create bus priority on four and three lane road segments. That political support could come from a high-ridership bus rapid transit<sup>75</sup> (BRT)-branded service along Atherton St [ [see VE RC BRT](#) ].

The proposed station locations farther from traffic light approaches facilitate Transit Signal Priority upgrades [ [see Transit Signal Priority](#) ] because sensors do not have to account for stopping buses. Stations are arranged so both platforms are as far away from their respective next traffic light approach as possible.

The transitway should accompany mixed-use, dense, walkable development along the entire Atherton corridor, especially around and between Cherry Ln and Blue Course Dr,<sup>76</sup> and including the closest blocks to Atherton St of College Heights and parts of the golf course adjacent to Atherton St.

This transitway would vastly improve or facilitate the implementation of an Atherton hub [ [see Atherton Hub](#) ].

## Atherton Hub

*Create and market a station along the Atherton Transitway at Blue Course Dr which provides convenient transfers between routes.*

### NEW ADVANTAGES

Riders could leave campus on any route going to Atherton St, then transfer to a route going to their destination. An interlined adjunct route network [ [see Interlined Adjunct Route Network](#) ], or at least marketing current RC and NE routes as interlined [ [see existing RC NE interlining](#) ], would allow riders to board adjunct buses on campus in more places, then transfer to their correct bus at the Atherton hub.

Riders could travel inbound to the hub and change to a route offering different destinations on campus and downtown.

Riders could change trunks to access other suburban destinations without traveling downtown or waiting for a circulator NV or VN. This would be significantly more useful with close inbound/outbound platforms and a convenient connection between them.

### STRATEGY OPTIMIZATION

The hub could be branded as a transfer point today, but other improvements will allow for easier implementation:

- All apartment passes on corridors which pass through N Atherton St should provide access to all routes on N Atherton St, and in the future to all routes [ [see Apartment Pass Program](#) ]
- The Atherton Transitway [ [see Atherton Transitway](#) ] will allow all routes to stop at the same platforms, just before Blue Course Dr, and still turn left on to it [ **N** ]. Until the transitway is implemented, the stops at CVS and the Discovery Space could be used temporarily, although transfers between inbound and outbound buses would require a three minute walk
- All-door boarding and proof-of-payment [ [see Proof-of-Payment & All-Door Boarding](#) ] will allow riders to more easily enter and exit buses to transfer without requesting a transfer slip, although this only affects a small portion of riders, as most use unlimited passes
- Removing the express segments of adjunct routes along Atherton St to allow express buses to stop at the hub will make transfers significantly

<sup>75</sup> [“The Bus Rapid Transit Standard,” Institute for Transportation & Development Policy, June 21, 2016.](#)

<sup>76</sup> see North Atherton Redevelopment created for use by Ferguson Township at [jamesgraef.com/atherton](http://jamesgraef.com/atherton). James Graef, 2017.

more useful for some riders [ [see Interlined Adjunct Route Network](#) ]

- Dense, mixed-use development adjacent to the hub and along Atherton St will benefit from the extremely high transit accessibility and will create more demand for high frequency links to campus, downtown, and other parts of State College<sup>77</sup>

## Other Improvements

### TRANSIT SIGNAL PRIORITY

Implement transit signal priority in highly-signalized corridors to speed travel times. In order of priority:

- **Burrowes Rd at College Ave [ o1 ] and Beaver Ave [ o2 ], and Beaver Ave at Fraser St [ o3 ], for White**

### Loops and the HM, among other routes:

Location	% of Buses Stopped <sup>79</sup>	Avg Time Stopped <sup>79</sup>
<b>Burrowes Rd at College Ave</b>	84%	<b>46s</b>
<b>S Burrowes St at Beaver Ave</b>	83.3%	<b>40s</b>
<b>Beaver Ave at Fraser St</b>	83.3%	<b>19s</b>

- Along College Ave,<sup>80</sup> including on Shortlidge Rd at College Ave
- Along Beaver Ave, including the ramp from College Ave to University Dr<sup>81</sup> [ P ]
- University Dr at Lot 83 West (Hastings Rd) for the White Loop and other routes, and Hastings Rd at University Dr for the Blue Loop
- Adjust and improve along the Atherton Transitway [ [see Atherton Transitway](#) ] corridor as part of transitway implementation

Expansion of [the Transit Signal Priority] system would be beneficial.<sup>78</sup>



*Stopped buses which can not take advantage of transit signal priority because of the near-side stop on Atherton St at the Walker Building*

<sup>77</sup> see North Atherton Redevelopment created for use by Ferguson Township at [jamesgraef.com/atherton](http://jamesgraef.com/atherton). James Graef, 2017.

<sup>78</sup> [Jacobs, "Atherton Street Traffic Signal & ITS Improvements: Improvements Evaluation," Pennsylvania Department of Transportation, October 1, 2012.](#)

<sup>79</sup> Based on 25 trips at College Ave and 6 trips at Beaver Ave and Fraser St. The sixth bus, which avoided stopping at Beaver Ave and Fraser St stopped at Allen St for 21s. Average time stopped excludes buses which did not stop. See [appendix](#) for raw data.

<sup>80</sup> ["Centre County Long Range Transportation Plan 2044," Centre Regional Planning Agency, July 31, 2018, X-14.](#)

<sup>81</sup> [ibid.](#)

## FAR-SIDE STOPPING

Move bus stops to the far side of intersections to allow for future transit signal priority, and to allow all inbound buses to share a platform at stops where branching routes combine. In order of priority:

- **Atherton St at Walker Building [ Q ]**
- University Dr at Lot 83 West (Hastings Rd)
- N Atherton St at E Clinton Ave
- N Atherton St at N Hills Pl, both directions
- N Atherton St at Hillcrest Ave Outbound
- Vairo Blvd at North Atherton Place
- All new and altered stops near intersections with traffic lights

## QUEUE JUMPS TO BE INSTALLED

Install queue jumps to allow buses to get in front of traffic stopped at red lights.<sup>82</sup> In order of priority:

- **College Ave at Allen St,<sup>83</sup> with special attention needed to ensure buses queue according to departure time, so the first bus to leave can take advantage of the queue jump signal**
- University Dr at Lot 83 West (Hastings Rd)

## BUS STOP PULL-OFFS

Cease construction of– and remove existing bus pull-offs, as they slow buses re-entering mixed-traffic [ [see bus pull-offs](#) ]. Alternatively, bus lanes adjacent to bus pull-offs eliminate the issue of re-entering mixed-traffic.

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<sup>82</sup> VTA Transit, “Bus Rapid Transit,” 47.

<sup>83</sup> “Curbside Pull-Out Stop,” [Transit Street Design Guide](#), National Association of City Transportation Officials, April 2016.

Campus Network . Interlined Adjunct Route Network . Increased Trunk Frequency . Redesigned W Corridor . Rerouted Service to Bellefonte . Simplified Peak-Only Routes . Other Notes

## **Network Changes**

Maximize efficiency of buses currently operating to speed trips and expand accessible destinations

# Campus Network

Consolidate transit services on campus to provide more direct, more frequent service to all parts of campus and downtown.

## EXISTING CONDITIONS

Campus Shuttles are less frequent versions of their Loop counterparts for the busiest portions of their routes. Because they have slightly different routes and different stop locations, passengers cannot easily wait for either a Campus Shuttle or Loop going to the same place.

Because Campus Shuttles are less visible on campus, potential riders are less aware of where they could take the bus.

Duplicate facilities and administration are necessary for upkeep and operation of Campus Shuttles separate from CATA buses.

The Campus Shuttle loops' parallel sides are far apart enough to ensure most passengers must ride around the whole loop for a round trip, but the loops are oblong enough to be annoying to ride all the way around. This is remedied somewhat by the

route traveling in the opposite direction, but **the shuttle on Beaver Ave has a frequency of 35 minutes, which is the same amount of time it takes to walk between the two stops on the shuttle farthest from each other.**

## ISSUES RESOLVED

Shuttle service offers a connection between Curtin Rd and Pollock Rd directly via Bigler Rd [ **A** ], rather than through the stadium parking like the Blue Loop's route. The 35-minute headway northbound direction is paralleled by the White Loop, which provides service to more destinations including central campus on a slightly longer route with significantly improved frequency. V, N, R, W, K, F, S, A, and G routes serve the more frequent southbound direction and would provide free service with the implementation of a fare-free zone on campus [ [see Fare-Free Zone](#) ]. Other benefits include:

- These CATA routes serve Curtin Rd through central campus where there are more potential riders, rather than through East Halls
- These CATA routes combined have similar to vastly higher frequencies compared to the College Ave Campus Shuttle

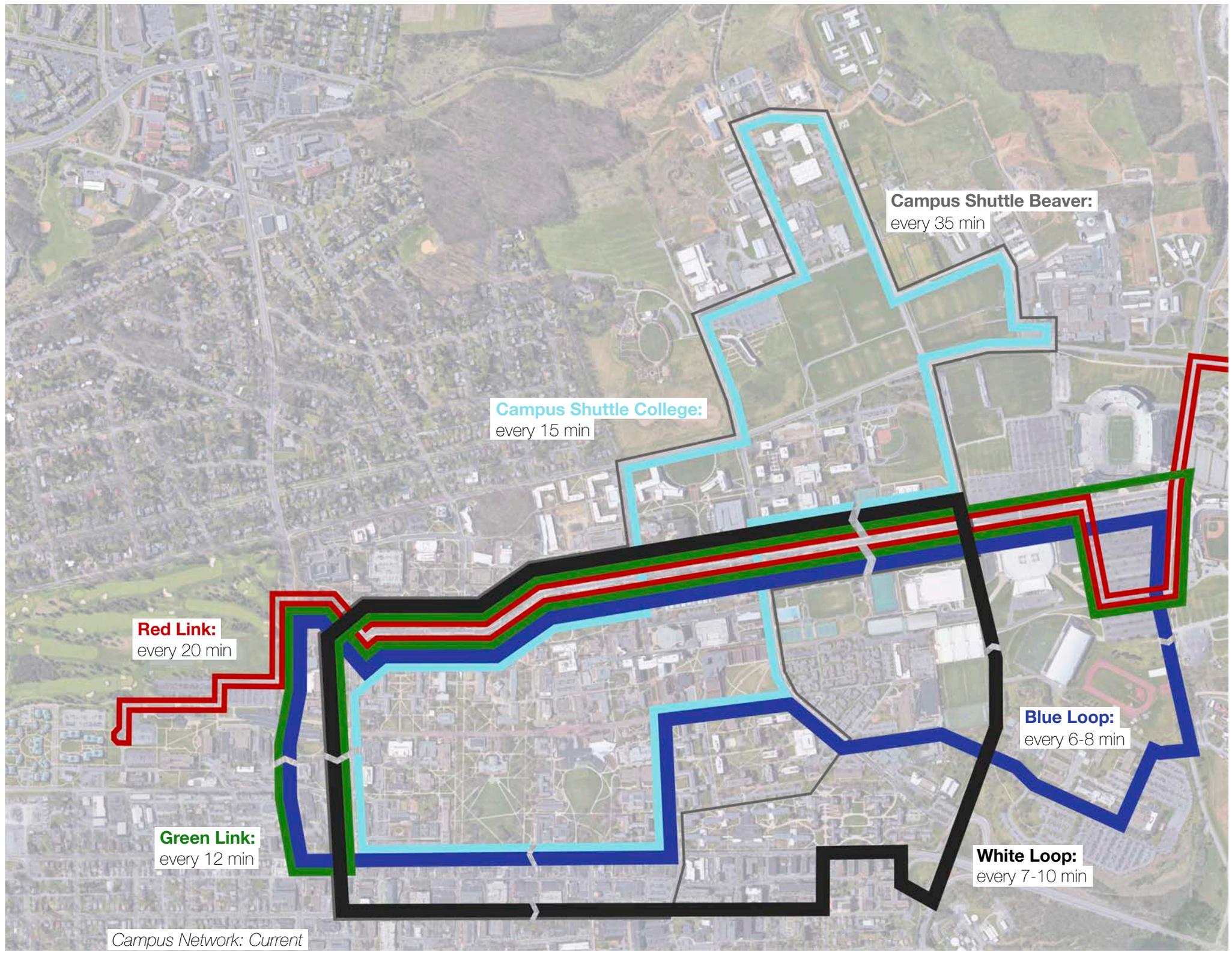
- These CATA routes offer service until late night, on weekends, and when Penn State is not in session

Service to stops on Shortlidge Rd near the business building would no longer be served directly [ **B** ]. New Loop and Link stops could be located at the greenway beside the Creamery [ **b1** ], just under 950 feet from the atrium of the business building—as compared to just over 550 feet from the Campus Shuttle stops—and closer to other buildings served by the existing stop. Advantages include:

- Significantly improved frequency in both directions to more popular destinations
- Stops between the Visual Arts building stops [ **b2** ] and East Halls



*Beaver Ave Campus Shuttle at Beaver Hill Apartments. This shuttle duplicates the White Loop downtown but does not stop here or at the CATA office*



**Campus Shuttle Beaver:**  
every 35 min

**Campus Shuttle College:**  
every 15 min

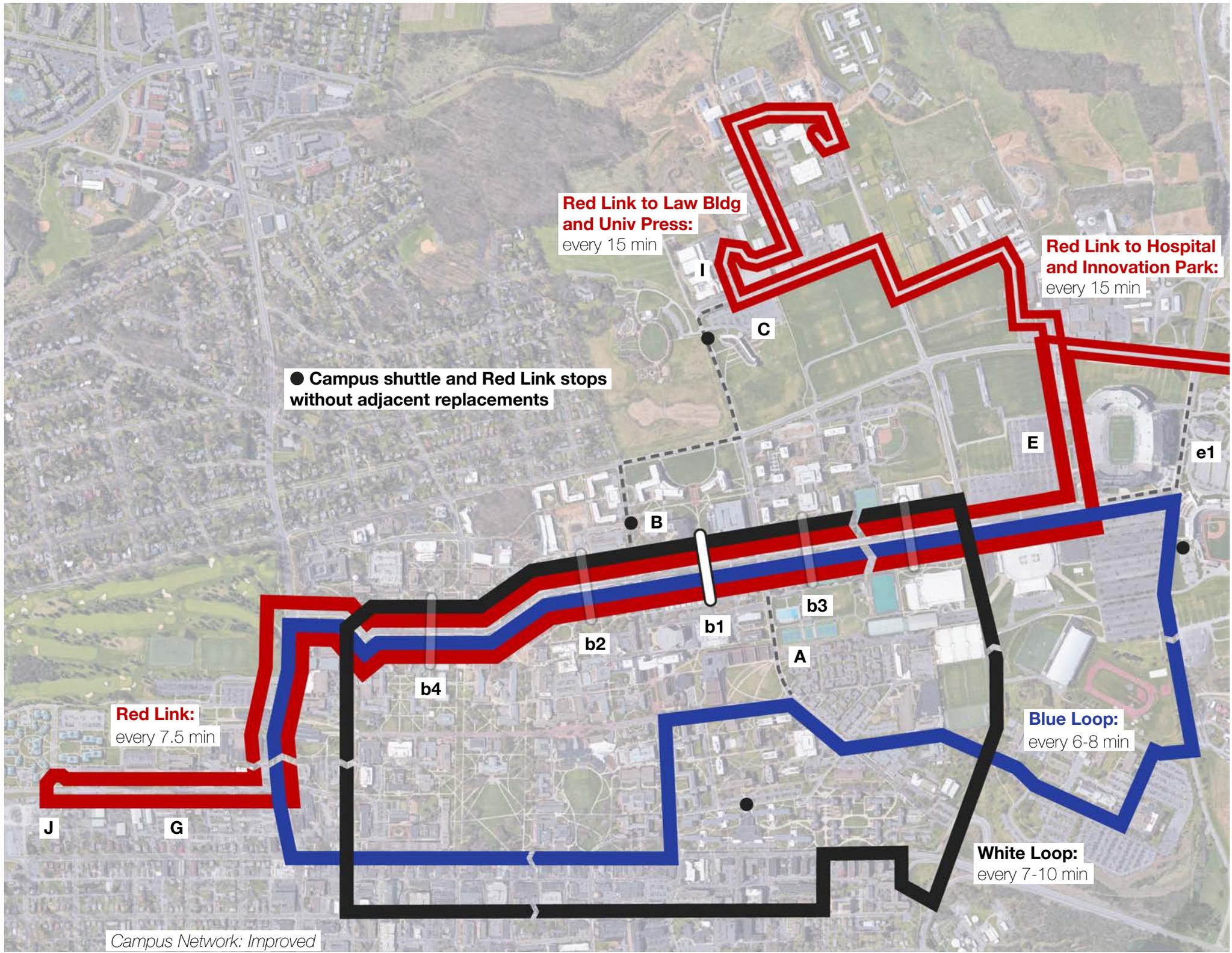
**Red Link:**  
every 20 min

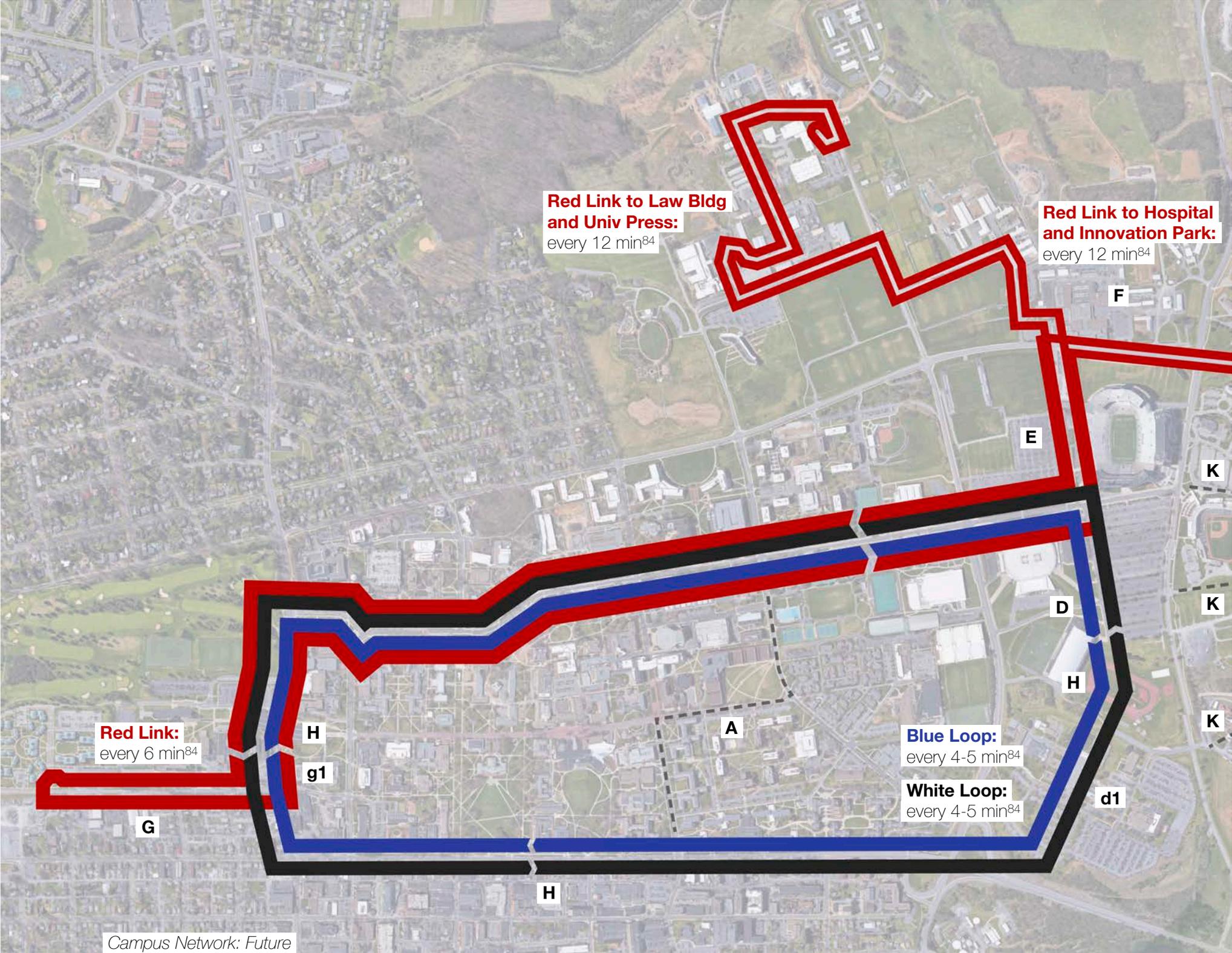
**Green Link:**  
every 12 min

**Blue Loop:**  
every 6-8 min

**White Loop:**  
every 7-10 min

*Campus Network: Current*





**Red Link to Law Bldg  
and Univ Press:**  
every 12 min<sup>84</sup>

**Red Link to Hospital  
and Innovation Park:**  
every 12 min<sup>84</sup>

**Red Link:**  
every 6 min<sup>84</sup>

**Blue Loop:**  
every 4-5 min<sup>84</sup>

**White Loop:**  
every 4-5 min<sup>84</sup>

H

g1

G

A

H

D

H

d1

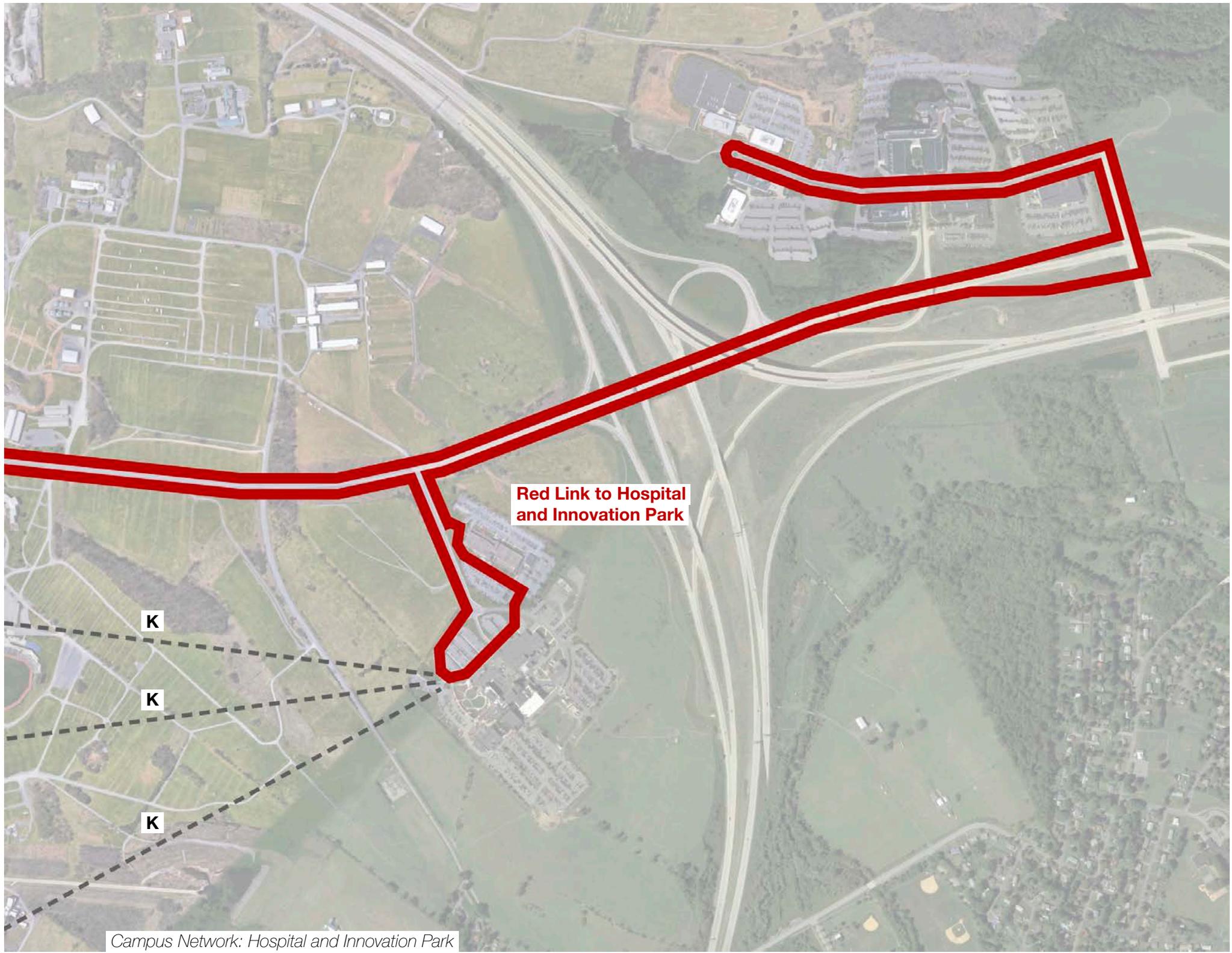
E

F

K

K

K



**Red Link to Hospital  
and Innovation Park**

**K**

**K**

**K**

*Campus Network: Hospital and Innovation Park*

stops [ **b3** ] shrink the distance between stops from 1950 feet to 1050 feet to Visual Arts and 900 feet to East Halls, much closer to the 1200 feet between Pattee Transit Center [ **b4** ] and the Visual Arts building stops.<sup>85</sup> These distances are slightly less than standard international best practice, but are more reasonable for short trips like the ones served by the Loops<sup>86</sup>

- These stops will serve future buildings in the location of the existing greenhouses on both sides of Curtin Rd well
- These stops could be used by community service as well, potentially encouraging moving the computer building stop farther down Bigler Rd

- The stops could be branded as business building stops, aided by the visual connection of the greenway, to encourage the association with the high-activity building

The stops in front of the the law building would be replaced by stops behind the building [ **C** ]. Slightly longer walks from the Arboretum and longer bus rides to the center of campus would be replaced by more visible, more frequent service to central campus, no longer stopping at OPP for schedule padding and an operator break.

In the future, Blue and White Loop service would be routed on the proposed Stadium Drive<sup>87</sup> [ **D** ] and a future extension to the south connecting to College Ave through a

potential mixed-use, dense extension of downtown<sup>88</sup> [ **d1** ]. Jordan East parking would be served by stops on the BJC side of the parking lot, which would be more convenient because they would be in the direction of central campus. The closest stop to Medlar Field would be 500 feet farther from the stadium's entrance. Closer White Loop service would provide better frequencies West on Curtin Rd than existing Green and Red Link services. In the interim, better Red Link service to Stadium West lots [ **E** ] would compensate for the loss of Red Link and Green Link service to Jordan East.

Both Red Link routes would run on the proposed Stadium Drive<sup>89</sup> [ **E** ] to allow for a shorter detour on the Law Building and University Press branch while keeping frequency higher on

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<sup>84</sup> Estimated headways with all improvements, including future Loop routing changes, all-door boarding [ [see Proof-of-Payment & All-Door Boarding](#) ], articulated buses [ [see Articulated Buses](#) ], and bus lanes [ [see Bus Lanes](#) ]. These changes increase capacity enough to eliminate the need for one bus to follow another at class changes. Based on proposed number of buses for Red Link and alternate number of buses for Loops.

<sup>85</sup> All distances measured from eastbound stops.

<sup>86</sup> Alon Levy, "Sometimes, Bus Stop Consolidation is Inappropriate," [Pedestrian Observations](#), October 30, 2018.

<sup>87</sup> Populous, "Athletics Facilities Master Plan," Penn State University, February 2017, 22.

<sup>88</sup> see Downtown East Redevelopment created for use by the State College Borough at [jamesgraef.com/downtown-east](http://jamesgraef.com/downtown-east). James Graef, 2019.

<sup>89</sup> [Penn State University, "Athletics Facilities," 22.](#)

<sup>90</sup> Number of buses and headways are measured during daytime weekdays during full service. Span of service might depend on funding, as current Green Link and Campus Shuttle routes only operate during these times.

## Existing Routes

	<b>Blue Link</b>	<b>White Link</b>	<b>Red Link</b>	<b>Green Link</b>	<b>Campus Shuttle College Ave</b>	<b>Campus Shuttle Beaver Ave</b>
cycle time	22 including break	20 including break	46 + 10 break at west campus + 4 break at innovation park	24 including break	23 + 7 break	29 + 6 break
number of buses <sup>90</sup>	3-4	2-4	3	2	2	1
headway (minutes)	<b>6-8</b>	<b>7-10</b>	<b>20</b>	<b>12</b>	<b>15</b>	<b>35</b>

## Proposed Routes

	<b>Blue Link</b>	<b>White Link</b>	<b>Red Link to Hospital and Innovation Park</b>	<b>Red Link to Law Building and Univ Press</b>
cycle time	22 including break	20 including break	47 + 7 break at west campus + 6 break at innovation park -or- + 2 break at innovation park and service to Hospital inbound	53 + 7 break at west campus
<b>Proposed: additional frequency on Red Link</b>				
number of buses	3-4	2-4	4	4
headway (minutes)	<b>6-8</b>	<b>7-10</b>	<b>15 branch / 7.5 core</b> (equivalent: RL+GL evenly spaced)	
future headway <sup>84</sup>	4-5	4-5	12 branch / 6 core	
<b>Alternate: additional frequency on Loops</b>				
number of buses	4-5	3-5	3	3
headway (minutes)	<b>4-6</b>	<b>6-8</b>	<b>20 branch / 10 core</b>	

Stadium Drive. Higher frequencies near Stadium West parking would make access to central campus from this parking lot more convenient. The route change from Porter Rd could be implemented separately if Stadium Drive is not complete when other route changes are implemented [ e1 ].

Integrating staff and equipment from Penn State Transportation Services into CATA will be challenging. One Red Link branch could be operated by the existing Penn State staff separate from CATA for an interim period. The branch should be branded as a CATA service paid for by Penn State to maintain consistency with other campus service. The branch should use CATA buses to maintain consistent branding, but the buses could be stored at the existing Penn State bus storage site except when maintenance is required. In the

future, the area around OPP [ F ] might be a good location for a new bus depot, and this arrangement could start coordination [ see second CATA depot ]. In the future the shuttle operators could become CATA employees. Red Link buses should be 40 foot or larger buses, but existing Campus Shuttle buses could be transferred to CATA peak-only community service routes or CATARide services.

### NEW ADVANTAGES

The Red Link routing would offer higher frequency service on more direct routes to buildings north of Park Ave, the hospital, and Innovation Park.

Loop and Link routes would offer higher and more consistent frequencies on Curtin Rd, downtown, and in areas

around College Ave and Atherton St, including Walker Building.

Loop and Link routes would provide more visible service where they replace Campus Shuttle routes.

Places where the Red Link replaces the Green Link, including West Campus, would see increased frequencies and increased service afternoons, evenings, nights, and weekends.

Red Link service on the Old Railroad Grade would offer higher frequency on a route closer to West College Ave urban village [ G ]. Frequent service to West College Ave replaces and adds to existing Green Link capacity at Walker Building with more convenient service for most people. The same service is also more convenient for people traveling from East Halls to West College Ave late Friday and Saturday nights, relieving crowding on White Loop service.

Limited investment would be necessary to create a contra-flow bus lane or two way street through the Greyhound bus station and along the Old Railroad Grade and to create a bus turn around at Duff Dr near the White Course Apartments. This route change could be implemented after other changes depending on funding availability.

The stop at Walker Building should be moved north of the intersection with the Greyhound Bus Station [ g1 ] to



*Blue Loop arriving to almost 100 riders waiting for it at a class change*

allow buses on the new Red Link route to stop at the same stops as buses on Atherton St, like the Green Link does currently. This will also allow for transit signal priority [ [see Transit Signal Priority](#) ]. Changes to the northbound stop should happen in conjunction to the addition of a southbound stop at the Walker Building, before or with the implementation of the Atherton Transitway [ [see Atherton Transitway](#) ].

Converting College Ave—or Beaver Ave—to a two-way transitway [ [see Bus Lanes](#) ], routing the While Loop via Atherton St, and combining both Loops between University Dr and Porter Rd [ [see Stadium Drive](#) ] would allow for the Loops to be seen as a single route in both directions [ **H** ].

## STRATEGY OPTIMIZATION

The Red Link to Law Building and Univ Press route accesses the Law Building and Arboretum [ **I** ] before and after stops to the North because predicted ridership to these destinations is higher, but the route could access University Press before the Law Building if ridership warrants the change. A loop should be avoided because a schedule padding and

operator break will likely be necessary, meaning riders on each side of the loop will need to wait onboard in one direction.

## OPPORTUNITIES & POSSIBILITIES

In the future, all buses on College Ave and Beaver Ave west of Atherton St could be consolidated onto the Old Railroad Grade, creating a unified, frequent trunk west of downtown. This trunk would be significantly stronger with increased frequency from a redesigned W corridor [ [see Redesigned W Corridor](#) ]. A connection between W Campus Dr near Duff Dr and College Ave would be necessary for continuous service, [ **J** ] potentially as part of the West Campus parking garage project.<sup>91</sup>

The W route could become the Red Link downtown and on campus, more efficiently using revenue hours. A fare-free zone on campus [ [see Fare-Free Zone](#) ] would easily allow for fare collection on the W route, and allow the Red Link to remain free near West Campus and on the rest of its current route. Some Red Link buses could short turn where they do currently and others could continue, allowing for a

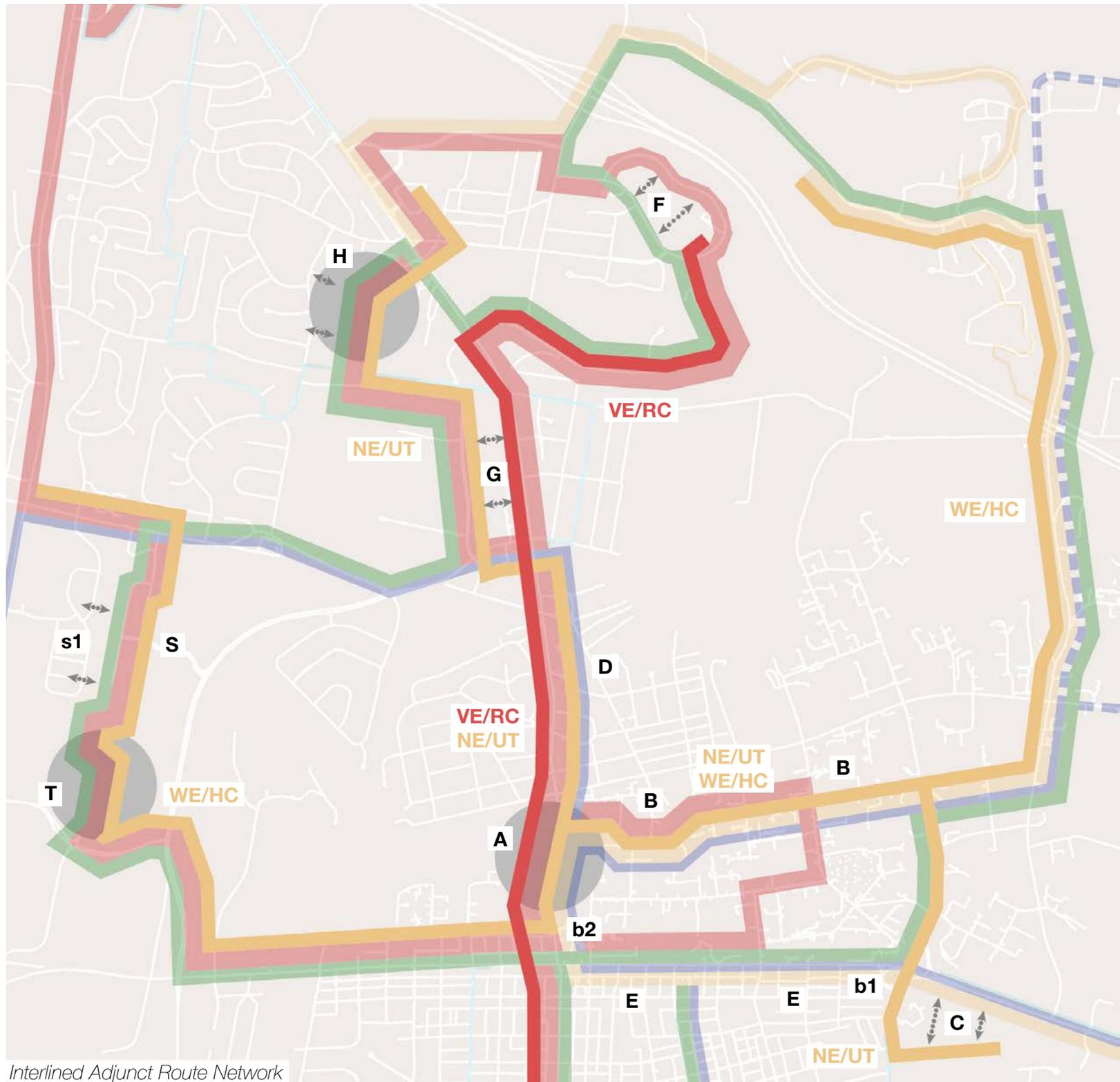
range of frequencies. This route and a redesigned WE/HC route [ [see Interlined Adjunct Route Network](#) ] would create one, more frequent corridor on Curtin Rd for all daytime services to destinations on the W corridor, reducing reverse branching.<sup>92</sup> NV and VN would provide service directly to all of downtown nights and weekends. **Some students are already hesitant to ride the Red Link because they are afraid they will end up at Innovation Park or West Campus, so education and advertising would be necessary to inform students where the route goes.**

Future expansion of campus East past Porter Rd, including potential changes to football tailgating fields<sup>93</sup> should attempt to create a connection between Porter Rd and Mount Nittany Medical Center [ **K** ] so the Red Link branch does not need to detour to serve the hospital and can serve it in both directions easily.

<sup>91</sup> CNET, “State College Borough Council Meeting,” State College Municipal Building, November 19, 2018, 16:53.

<sup>92</sup> Alon Levy, “The Wrong Kind of Branching,” Pedestrian Observations, February 4, 2015.

<sup>93</sup> Penn State University, “Athletics Facilities,” 84-86.



*Interlined Adjunct Route Network*

# Interlined Adjunct Route Network

*Interline NE, WE, HC, and UT routes to serve campus more completely and to decrease overall trip time.*

*Interline VE and RC routes to create an Atherton trunk which can be expanded in the future.*

## EXISTING CONDITIONS

Existing trunk routes waste revenue hours and rider time looping around campus and downtown, but adjunct routes—express and campus services—generally do not serve campus and downtown well.

The HU route planned in the Fall 2019 service changes will serve campus and downtown well, but the Toftrees and Bellaire Ave corridors are the two lowest-ridership adjunct routes.

## NEW ADVANTAGES

The VE/RC route grants VE buses easy access to downtown at Atherton St [ **b2** ] and creates a bus line running a significant length solely on Atherton St. These services could be combined today, with buses looping through Pattee Transit Center in both directions, but the Atherton Transitway [ [see Atherton Transitway](#) ], or at least bus stops in both directions at Rec Hall and Walker Building on Atherton St [ **A** ] would allow for routing on Atherton St without detours.

The HU route implemented in Fall 2019 would be separated, and the segments running the length of campus and downtown would be used to connect the HU route to the NE and WE routes [ **B** ]. The NE is connected to the UT [ **b1** ] and the WE is connected to the HC [ **b2** ] to allow both routes to access downtown on opposite sides. The WE/HC route could be interlined via Atherton St before W corridor changes [ [see Redesigned W Corridor](#) ] occur, although the route would not see the benefits of serving downtown.

Campus Service changes [ [see Campus Network](#) ], especially with the Atherton Transitway [ [see Atherton Transitway](#) ] and a transitway on College Ave or

Beaver Ave [ [see Bus Lanes](#) ], would allow riders to transfer to extremely frequent campus services to access the rest of campus and downtown from adjunct routes.

## STRATEGY OPTIMIZATION

Through-running routes should be branded as single routes to advertise one-seat rides, especially along Atherton St.

**Create pedestrian and bike connections between Bellaire Ave and College Ave to allow UT riders to access service on College Ave more easily [ **C** ].** This will allow the NE/UT to stop serving Bellaire Ave directly and be extended to the Mall as development occurs, creating a more complete only-adjunct network.

All adjunct services on N Atherton St should serve stops on N Atherton St, rather than becoming express, so they function more like trunk routes [ **D** ] [ [see VE RC BRT](#) ], and so the route serves all of Atherton St [ [see Atherton Hub](#) ]. The N Atherton St corridor would become the most attractive corridor outside downtown for dense, mixed-use development.<sup>94</sup>

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<sup>94</sup> see North Atherton Redevelopment created for use by Ferguson Township at [jamesgraef.com/atherton](http://jamesgraef.com/atherton). James Graef, 2017.

## OPPORTUNITIES & POSSIBILITIES

The VE/RC route should be encouraged to develop into a bus rapid transit<sup>95</sup> (BRT)-like corridor along Atherton St, with an emphasis on serving commercial development to encourage diverse community ridership. As N Atherton St develops, and especially with the development of Patton Crossing, the VE and NE branches could be swapped—NE/RC and VE/UT or a future Mall adjunct route—to keep the Atherton St corridor closer to Atherton St all the way to The Colonnade. Dense, walkable development should be encouraged on the entire length of S Atherton St stretching south from downtown, eventually dwarfing development on Waupelani Dr, to allow the transit corridor to continue to important commercial destinations like Hills Plaza, and to market the corridor as serving all of Atherton St.

**The existing interlining of the RC and WE routes should be advertised by changing RC buses to WE signage before downtown and the Walker Building, like the N and R routes do, to allow WE riders service to and from downtown before all six routes are interlined.**

The NE/UT route could route through downtown, rather than Curtin Rd, to create a more complete adjunct route network [ **E** ]. A stop at Rec Hall on Atherton St and increased and more efficient Campus Service would allow riders to access all of central campus [ **A** ].

More resources should be given to adjunct routes as they evolve into more efficient trunk routes. For example:

- When efficiency and funding allow for shorter headways on trunk corridors [ see Increased Trunk Frequency ], trunk route headways could be changed to 30 minutes rather than 15 on-peak and 30 off-peak, and adjunct route headways could be doubled to 10 minutes, rather than increased to only 15.
- Adjunct and circulator service could be added on weekends and during reduced service to add needed trunk capacity or to replace trunk service. Increases in efficient circulator service and adjunct routes which serve the edges of downtown [ **b1**, **b2** ] would compensate for lost inefficient trunk service downtown. Pedestrian connections should be improved in places like Oakwood Ave, between the current V and NV/

VN routes, to ease riders through the transition [ **F** ].

- **Investigate replacing circulator route service late-night, especially Friday and Saturday, with adjunct route service.** Late night Friday and Saturday are some of the most productive times for all three circulator routes<sup>96</sup> and most ridership on the NV and VN routes comes from The Heights and Toftrees. Circulator service could be replaced by WE/HC service via downtown rather than campus—potentially branded as a different route—and VE/RC service on Atherton St, also replacing RP service. VE service would be within walking distance of Martin St and Aaron Dr, especially with additional pedestrian and bike connections between Atherton St and Martin St [ **G** ]. These routes would provide faster trip times, simplify service patterns, and potentially cost less to operate. When NE/UT service is extended to the Mall and the Villas at Happy Valley rather than Bellaire Ave, it could also operate via downtown late nights similar to WE/HC service.

<sup>95</sup> "The Bus Rapid Transit Standard," Institute for Transportation & Development Policy, June 21, 2016.

<sup>96</sup> Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 20-94.

# Increased Trunk Frequency

Implementing all-door boarding and dedicated transit right-of-way will increase bus speed and reliability

enough to allow the interlined V, N, and R routes to run on 30 rather than 40 minute headways with just one additional bus.

Implementation of the interlined adjunct routes [ see [Interlined Adjunct Route Network](#) ] and slight schedule modifications will allow all adjunct routes to run on 15 minute headways.

## EXISTING CONDITIONS

Adjunct and trunk services are almost universally full during peaks and crowded at all other times. Adjunct services like the VE and RC often have two buses running together constantly or occasional tripper buses for extra capacity.

40 minute frequencies are inconvenient for riders to remember and for CATA to

### Current Interlined Trunk Scheduling

Route	V		N		R		N		V				
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	College & Allen	Col-onnade	Col-onnade	College & Allen	College & Allen	Stratford Dr	Stratford Dr	College & Allen	College & Allen	Col-onnade	Col-onnade	College & Allen	College & Allen
Min to next point	20	7	27	0	9	5	26	0	21	6	29	0	
Timestamp	0:00	0:20	0:27	0:54	0:54	1:03	1:08	1:34	1:34	1:55	2:01	2:30	2:30
Example trip	10:18	10:38	10:45	11:12	11:12	11:21	11:26	11:52	11:52	12:13	12:19	12:48	12:48

### Proposed Interlined Trunk Scheduling

Route	V		N		R		N		V				
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	College & Allen	Col-onnade	Col-onnade	College & Allen	College & Allen	Stratford Dr	Stratford Dr	College & Allen	College & Allen	Col-onnade	Col-onnade	College & Allen	College & Allen
Min to next point	20	7	27	3	9	5	26	3	21	6	29	4	
Timestamp	0:00	0:20	0:27	0:54	0:57	1:06	1:11	1:37	1:40	2:01	2:07	2:36	2:40
Example trip	10:18	10:38	10:45	11:12	11:15	11:24	11:29	11:55	11:58	12:19	12:25	12:54	12:58

## Current / Potential Fall 2019 Interlined Adjunct Route Scheduling

Route	VE				NE				VE
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	Oak-wood	Oak-wood	Pattee TC	Pattee TC	Trader Joe's	Trader Joe's	Pattee TC	Pattee TC
Min to next point	11	17	12	0	14	11	15	0	
Timestamp	0:00	0:11	0:28	0:40	0:40	0:54	1:05	1:20	1:20
Example trip	10:19	10:30	10:47	10:59	10:59	11:13	11:24	11:39	11:39

Route	RC				WE				RC
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	CATA Depot	CATA Depot	Pattee TC	Pattee TC	The Heights	The Heights	Pattee TC	Pattee TC
Min to next point	17	14	17	0	14	9	9	0	
Timestamp	0:00	0:17	0:31	0:48	0:48	1:02	1:11	1:20	1:20
Example trip	10:14	10:31	10:45	11:02	11:02	11:16	11:25	11:34	11:34

Route	HC				UT				HC
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	The Station	The Station	Pattee TC	Pattee TC	Bellaire Ave	Bellaire Ave	Pattee TC	Pattee TC
Min to next point	12	7	14	0	13	14 <sup>97</sup>	11	0	
Timestamp	0:00	0:12	0:19	0:33	0:33	0:46	1:00	1:11	1:11
Example trip	10:31	10:43	10:50	11:04	11:04	11:17	11:31	11:42	11:42

write because they do not repeat on the hour [ [see Stop Info Panels](#) ].

### ISSUES RESOLVED

All redesigned adjunct route groups [ [see Interlined Adjunct Route Network](#) ] can use the same amount of buses to run at 15 minute headways, with fewer breaks for schedule padding<sup>98</sup> because bus lanes [ [see Bus Lanes](#) ] and all-door boarding [ [see Proof-of-Payment & All-Door Boarding](#) ] allow for higher speed and reliability. The VE/RC route is five minutes longer than necessary for 15 minute headways with the same number of buses, but the removal of the loop to serve Pattee, with new stops on Atherton St at Rec Hall [ [see Atherton Transitway](#) ] would make up more than the necessary five minutes.

The V/N/R triple can be reduced easily to a 2:30 runtime by removing schedule padding breaks at College and Allen made unnecessary by bus lanes [ [see Bus Lanes](#) ] and all-door boarding [ [see Proof-of-Payment & All-Door Boarding](#) ],<sup>99</sup> meaning only one extra bus is necessary to increase

<sup>97</sup> Wait at Bellaire Ave alternates: 9, 14 minutes

<sup>98</sup> Schedule padding goal of 12 minutes, 8 minimum. [Alon Levy, "Boston NightBus: Planning Around Timed Connections," Pedestrian Observations, January 5, 2017.](#)

<sup>99</sup> [Alon Levy, "Bus Bunching."](#)

### Proposed Interlined Adjunct Route Scheduling

Route	RC				VE				RC
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	CATA Depot	CATA Depot	Pattee TC	Pattee TC	Oak-wood	Oak-wood	Pattee TC	Pattee TC
Min to next point	17	8	17	0	11	0	12	0	
Timestamp	0:00	0:17	0:25	0:42	0:42	0:53	0:53	1:05	1:05
Example trip	10:14	10:31	10:39	10:56	10:56	11:07	11:07	11:19	11:19

Route	NE				UT				NE
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	Trader Joe's	Trader Joe's	Pattee TC	Pattee TC	Bellaire Ave	Bellaire Ave	Pattee TC	Pattee TC
Min to next point	14	11	15	0	10	0	10	0	
Timestamp	0:00	0:14	0:25	0:40	0:40	0:50	0:50	1:00	1:00
Example trip	10:31	10:45	10:56	11:11	11:11	11:21	11:21	11:31	11:31

Route	HC				WE				HC
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Pattee TC	The Station	The Station	Pattee TC	Pattee TC	The Heights	The Heights	Pattee TC	Pattee TC
Min to next point	12	0	14	0	14	11	9	0	
Timestamp	0:00	0:12	0:12	0:26	0:26	0:40	0:51	1:00	1:00
Example trip	10:31	10:43	10:43	10:57	10:57	11:11	11:22	11:31	11:31

frequency from 40 minutes to 30, and two to increase from 20 minutes to 15 during peaks. Tripper or duplicate buses—no longer-necessary due to higher frequencies or articulated buses [ [see Articulated Buses](#) ]—could be used as the extra buses on the V/N/R route group.

Future route changes will make scheduling less tight and might reduce the number of buses necessary. For example, routing the N and NE through Patton Crossing via Wolf Ln, rather than Park Ln, with better pedestrian and bike connections between the two [ **H** ] [ [see Simplified Peak-Only Routes](#) ], and routing the W and WE through Pine Hall development [ **T** ] via College Ave rather than on Atherton St and Blue Course Dr [ [see Redesigned W Corridor](#) ].

Eliminating the schedule padding breaks at College and Allen will make timed transfers more delicate, but this is acceptable:

- The vast majority of riders do not transfer, and their time spent waiting is much more than the increase in wait time for transferring riders
- Bus lanes will decrease variability in trip times dramatically, leading to more reliable timed transfers
- It is possible to walk from Pattee Transit Center to College Ave and Allen St faster than it is to stay on a V, N, R, or W bus, so riders could catch

## Existing Routes

	V N R	VE NE	RC WE	HC UT
cycle time	2:40	1:20	1:20	projected: 1:11 1:20 with breaks
headway (minutes)	<b>40</b>	<b>20</b>	<b>20</b>	<b>HC 40 / UT 30,35</b> <b>Fall 2019: 20</b>
number of buses	4	4	4	current: 2 Fall 2019: 4

## Proposed Routes

	V N R	VE RC	NE UT	WE HC
cycle time	2:30	1:00 <sup>100</sup>	1:00	1:00
number of buses	5	4*	4	4
headway (minutes)	<b>30</b>	<b>15</b>	<b>15</b>	<b>15</b>

transfers they otherwise would not be able to catch by walking

- Increased frequency will generally shorten all transfers
- Interlined adjunct routes [ [see Interlined Adjunct Route Network](#) ] and interlined N and R service provide links through downtown and campus without necessary transfers

### STRATEGY OPTIMIZATION

The only remaining routes on 40 minute headways—the HM and W on weekdays—could be changed later to 30 minute headways. Although the HC/WE route could be changed without operating cost increases, it should retain 20 minute headways until the W and HM frequencies are changed to maintain consistent corridor headways. The following would be necessary to transition to 30 minute headways:

W: If, via all-door boarding [ [see Proof-of-Payment & All-Door Boarding](#) ] and bus lanes [ [see Bus Lanes](#) ], schedule padding breaks at College and Allen and three minutes of travel time on campus and downtown were removed from the V, N, R, and W routes, the W could be interlined with the V downtown and the four routes could be operated at 30 minute headways with no additional buses, other than the one

<sup>100</sup> 5 buses necessary with 1:15 cycle time while route still detours through Pattee Transit Center before stops are created on Atherton St [ [see Atherton Transitway](#) ]

necessary for 30 minute V, N, and R service. Reliability concerns should be considered with such a long route, though bus lanes would be installed on the most congested corridors.

Alternatively, removing detours like those on Galen Dr and Amblewood Way in favor of service by the A route [ see [Simplified Peak-Only Routes](#) ] could allow for increased frequency.

HM: one extra bus, without schedule alterations, would probably be necessary to increase HM frequency from 40 to 30 minutes.

## OPPORTUNITIES & POSSIBILITIES

Corridor headways could be coordinated with circulator routes already running at 30 and 60 minute frequencies.

Pulses downtown could be coordinated with 60 minute-headway corridor routes.

# Redesigned W Corridor

*With the construction of the Pine Hall development, the W corridor can easily be routed through College Ave rather than Atherton St, spreading frequent transit service.*

*The current K route can be rerouted through Atherton St to serve areas previously served by the W and S routes, allowing for the removal of the S route.*

## EXISTING CONDITIONS

No routes are currently located well to be extended to serve the new Pine Hall development<sup>101</sup> next to The Heights.

Commercial buildings on Science Park Rd north of Old Gatesburg Rd only receive peak-only service.

So many routes accessing campus and downtown through Atherton St create an unbalance, prohibiting corridors from being interlined north-south through campus and downtown.

College Ave west of Atherton St is underserved by transit, especially on weekdays, which hurts dense, walkable redevelopment potential.<sup>102</sup>

The KP route to be created in Fall 2019 detours in a loop on Atherton St and Burrowes Rd in both directions to serve the edge of central campus.

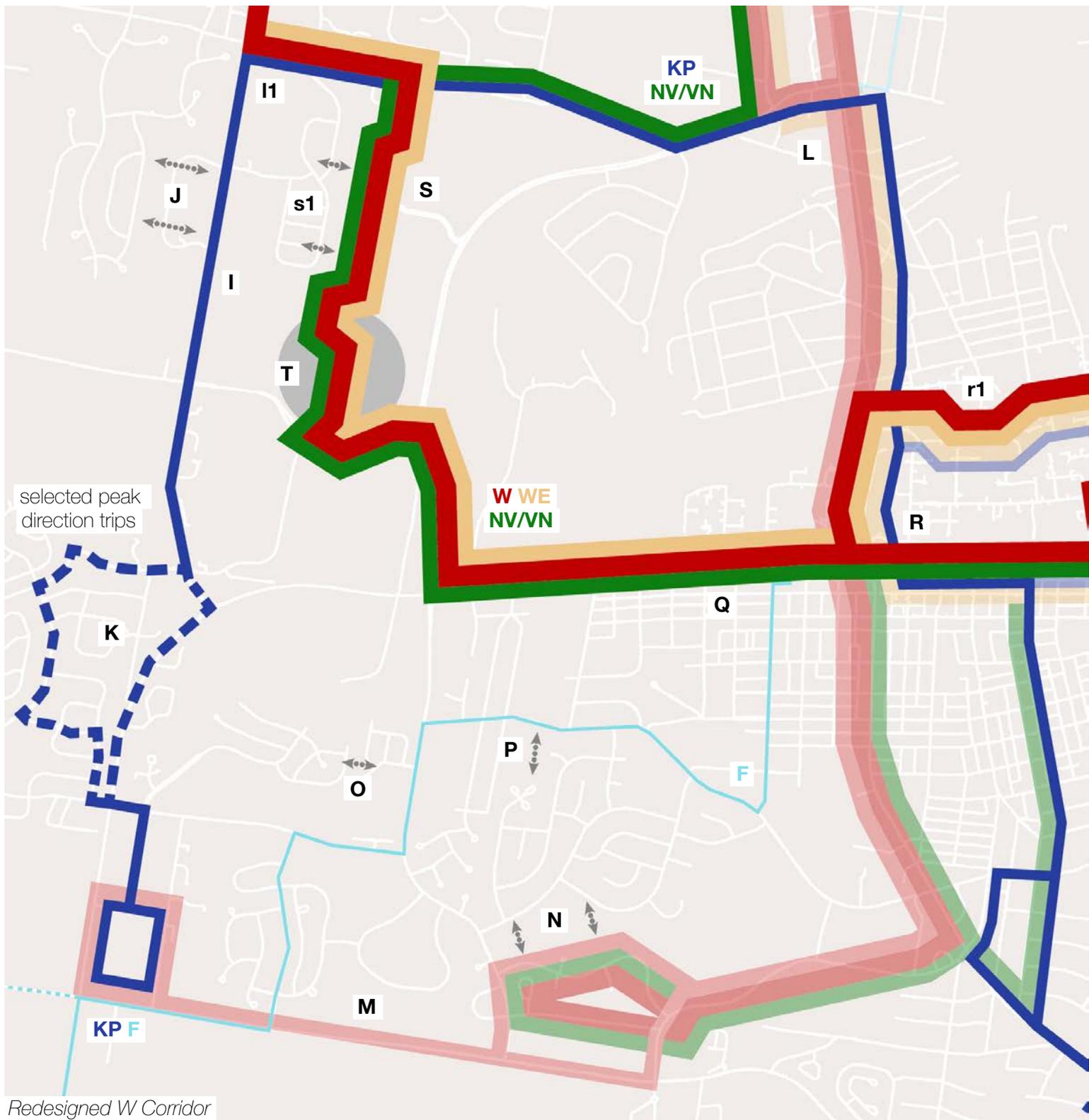
## ISSUES RESOLVED

Corridor types are maintained so corridor frequencies and spans can be consistent: the W route's Pine Hall/The Heights and Valley Vista are generally clusters of dense residential, whereas the KP route's Science Park Rd and Cato Park are both commercial.

The S route is removed, replaced by rerouted KP and F routes. The entirety of the commercial section of Science Park Rd receives hourly service, rather than peak-only service, with the KP route [ I ]. Additional pedestrian and bike connections should be created between Barnstable Ln, Sandy Dr, and Science Park Rd [ J ]. **Because Cato Park is a reverse-peak destination, select peak-direction trips on the KP can replace the S route in Autumnwood without disrupting the**

<sup>101</sup> LandDesign, "Pine Hall Traditional Town Development General Master Plan," Ferguson Township, February 15, 2018.

<sup>102</sup> Luke Derda, Dave Eilenberger, Lillian Luu, Rick McDonald, & Jason Miller, "Terraced Streetscape District," Smeal Applied Professional Experience, Penn State University, 2015.



Redesigned W Corridor

**reverse-commutes of most Cato Park riders [ K ]**. Service to Science Park Rd and Cato Park passes Atherton at Blue Course [ L ], allowing riders on the V and N corridors—and W corridor at Circleville Rd [ I1 ]—to transfer to the KP without traveling downtown, aided by a future Atherton Hub [ [see Atherton Hub](#) ]. Cato Park is also served on the opposite side of town by the slightly more direct RC route from campus and downtown [ M ].

F service travels on Westerly Pkwy rather than Bayberry Dr to serve almost all riders of the S before Science Park Rd. Pedestrian and bike connections between Bayberry Dr and Southgate Dr [ N ] should be expanded to allow current F route riders to access the more frequent R corridor. Pedestrian and bike connections between The Landings and Sylvan View [ O ] and between Westway Gardens and Shamrock Estates [ P ] should be expanded to allow better access to the F route.

## NEW ADVANTAGES

Because the K portion of the KP route would access campus and downtown through Atherton St, the loop to central campus would no longer be a detour.

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<sup>103</sup> [Alon Levy, “Wrong Branching.”](#)

W and WE routes move from Atherton St to College Ave [ Q ] to access Campus and downtown. Service on College Ave allows buses to access the edge of downtown quickly [ R ], before serving central campus [ r1 ], unlike currently on Atherton St where downtown is first served after all of campus. Both routes should access campus and downtown via the same corridor, College Ave, because reverse branching makes transit significantly less efficient.<sup>103</sup> Circulator NV and VN service will allow for connections to Giant and destinations on Atherton St; and development on College Ave west of Atherton St will create more commercial destinations on the W corridor.

## STRATEGY OPTIMIZATION

W, WE, NV, and VN buses should be routed on Northwick Blvd for its entirety [ S ], rather than Havershire Blvd, then Southwick Blvd and directly through the Pine Hall development [ T ] to Old Galesburg Rd at its intersection with Pine Hall Rd. Pedestrian and bike connections should be expanded between Greenleaf Manor and Northwick Blvd for better transit access in Greenleaf Manor [ s1 ].

W, WE, and F buses should turn from Beaver Ave to Atherton St, even

without the Atherton Transitway, if remotely possible, rather than to Burrowes St like the F bus does currently, to standardize routing for almost all routes northbound on Atherton St.

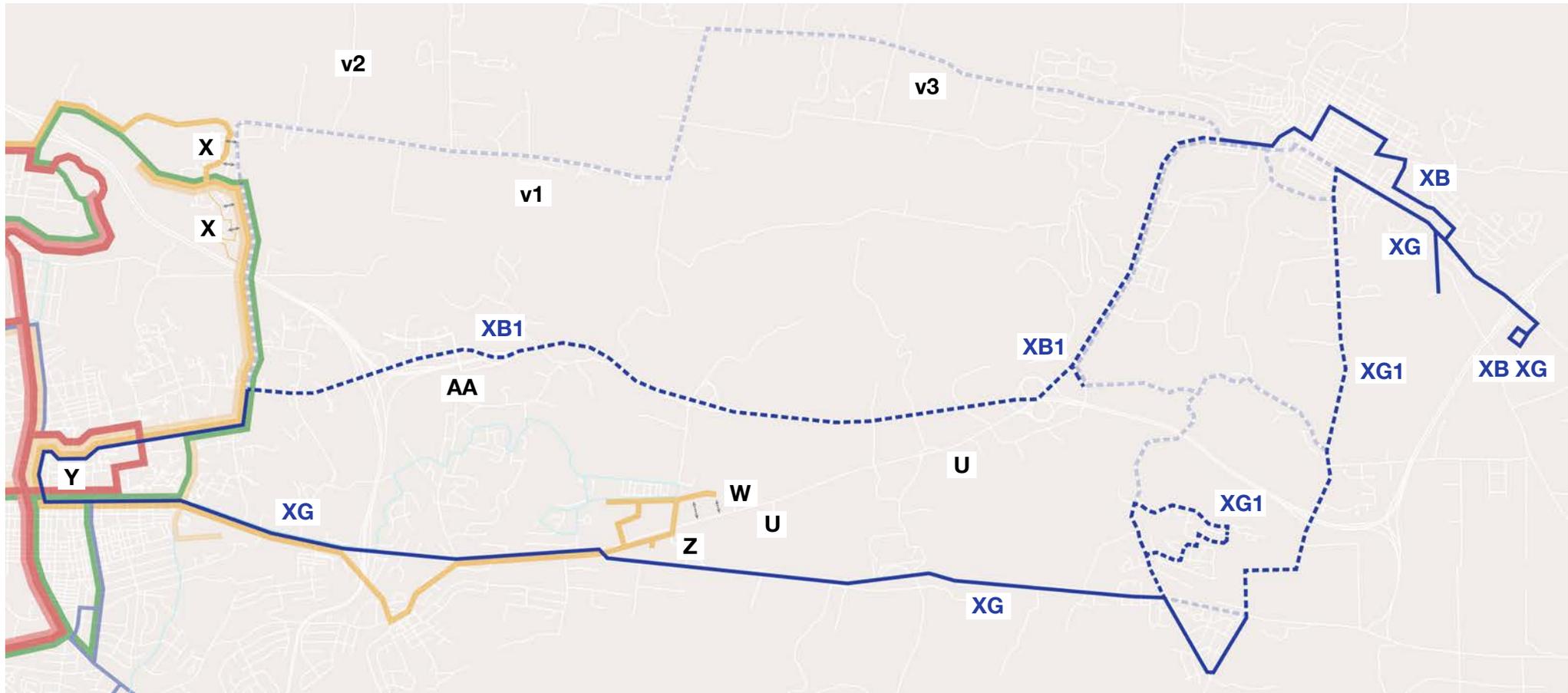
To allow northbound KP buses to stop near central campus, both directions should use Burrowes Rd, until a stop at Rec Hall on Atherton St is created [ A ].

## OPPORTUNITIES & POSSIBILITIES

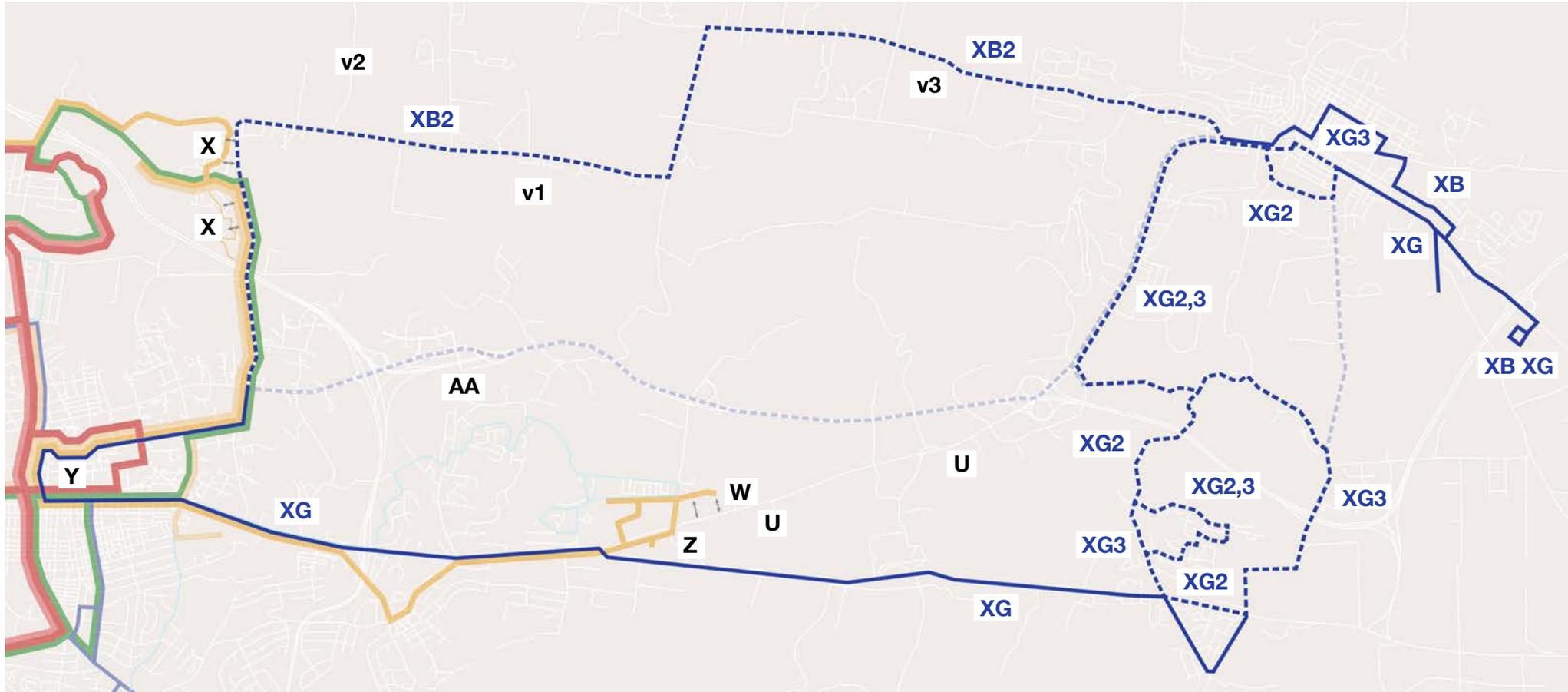
Explore interlining the W route with the Red Link and running the W corridor on the Old Railroad Grade to create more efficient or more frequent service through the West End Village and West Campus [ [see interlined W and Red Link](#) ].



*K route—future KP route—on Burrowes Rd where it will detour to serve campus*



*Rerouted Service to Bellefonte: Alternatives XB1 and XG1*



Rerouted Service to Bellefonte: Alternatives XB2, XG2, and XG3

# Rerouted Service to Bellefonte

Separating the XB and XG routes between Bellefonte and State College will allow for faster service to Bellefonte or service to the Airport and development around Route 550.

Shorter route cycles and increased ridership should be used to increase frequency of service to Bellefonte to a 60 minute headway.

## EXISTING CONDITIONS

XB service on Benner Pk and College Ave duplicates XG and HM service but does not meaningfully increase frequency.

Service on Benner Pk between Nittany Mall and I99 does not serve any residential or commercial development [ U ].

University Park Airport [ v1 ], ongoing development nearby in Patton Township [ v2 ], and existing development on Route 550 [ v3 ] currently have no transit service.

## Current Interlined Bellefonte Routes Scheduling

Route	XG				XB			XG	
Status	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave	Arrive	Leave
Stop	Weis	CATA: Schlow	CATA: Schlow	Weis	Weis	CATA: Schlow	CATA: Schlow	Weis	Weis
Min to next point	65	3	50	12	51	3	39	9	
Timestamp	0:00	1:05	1:08	1:58	2:10	3:01	3:04	3:43	3:52
Example trip	6:49	7:54	7:57	8:47	8:59	9:50	9:53	10:32	10:41

## Proposed Bellefonte Loop Scheduling <sup>104</sup>

Route	XG		XB		XG
Status	Leave	Arrive	Leave	Arrive	Leave
Stop	Weis	College & Allen	College & Allen	Weis	Weis
Min to next point	53	0	57	10	
Timestamp	0:00	0:53	0:53	1:50	2:00
Example trip	6:49	7:42	7:42	8:39	8:49

<sup>104</sup> Showing XB outbound and XG inbound. Another loop in the opposite direction would follow the same schedule in reverse.

XB and XG service is not hourly, but could easily be transitioned to 60 minute headways with the same amount of buses as are used at the peak.

## NEW ADVANTAGES

The XB route could run on I99 to Benner Pk [ **XB1** ] to shorten the route and nudge it and the XG closer to hourly service. Pedestrian and bike connections should be expanded from Premiere Dr to Benner Pk where the XB route would no longer stop [ **W** ], to allow all parts of Benner Pk with ridership which would lose XB service to still have more frequent HM service. XG service should be maintained on Blanchard St Exd [ **XG1** ].

Alternatively, the XB route could run on Fox Hill Rd, Rock Rd, and Buffalo Run Rd to Bellefonte [ **XB2** ]. This route would take the same amount of time as the current route on College Ave and Benner Pk does. This route would have the potential to serve the University Park Airport [ **v1** ], ongoing development nearby in Patton Township [ **v2** ], and existing development on Route 550 [ **v3** ]. The XB route could take over all or part of the HM route through Toftrees, except for Toftrees Ave. Pedestrian and bike connections should be expanded

between Fox Hollow Rd and Woodledge Dr and The Village at Penn State, especially if the XB route stays on Fox Hollow Rd [ **X** ]. The XG routing could be changed to serve the portion of Benner Pk north of I99 via Axemann rather than Blanchard St Exd [ **XG2,3** ], or service could be maintained on Blanchard St Exd [ **XG1** ], even though this road has little ridership outside Bellefonte.<sup>105</sup>

Both options would allow the XB and XG to use the HM routing downtown and on campus [ **Y** ], increasing efficiency and simplifying potential signage transitions between routes downtown and on campus.

The XG route would still allow riders from Bellefonte to access the Nittany Mall [ **Z** ].

## STRATEGY OPTIMIZATION

With the removal of the XG's detour to the Nittany Mall [ **Z** ], a one-way loop via **XB2** and **XG2** can take two hours, meaning four buses are necessary for hourly service on both routes. This would mean the same number of buses as run at peak would need to run all day for hourly service.

## OPPORTUNITIES & POSSIBILITIES

B and C routes could be interlined and routed through downtown and campus like the proposed XB and XG would if the Innovation Park Access Ramp road is connected to Houserville Rd [ **AA** ].

## Simplified Peak-Only Routes

*Minimize neighborhoods served by looping service on the B route and decrease winding route segments.*

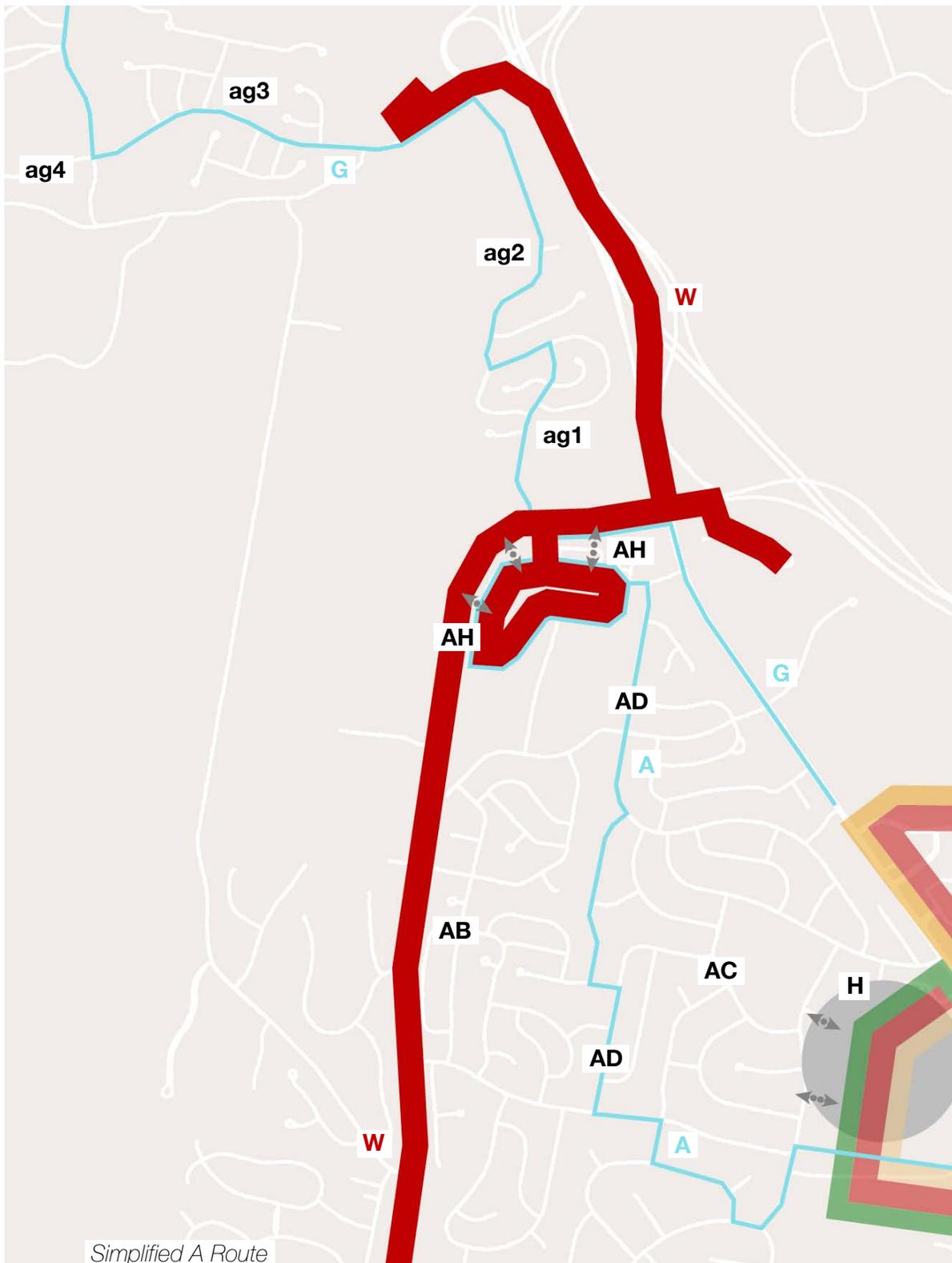
*Remove the loop on the A route in favor of a central Park Forest bi-directional route.*

## EXISTING CONDITIONS

Loop services require most riders to travel out of their way in one direction or travel significantly farther to reach another stop heading in the correct direction.

Current peak-only routes closely parallel more frequent routes, not

<sup>105</sup> Centre Area Transportation Authority, "Assessment of Articulated Bus Utilization," 86.



Simplified A Route

servicing areas farther from those frequent routes as well.

## ISSUES RESOLVED

The western side of the A loop in Park Forest is generally only one block from significantly more frequent W service [ **AB** ] and detours on the eastern side are near even more frequent N, NE, NV, and VN service [ **AC** ], so a single routing paralleling the eastern half of the loop without some detours [ **AD** ] still allows the entire neighborhood to be served. Even when the N corridor is moved to Wolf Ln and through Patton Crossing to the intersection of N Atherton St and Woodycrest St, expanded pedestrian and bike connections to Park Ln will allow for access to the corridor from nearby neighborhoods [ **H** ].

## NEW ADVANTAGES

The majority of the loop on the B route can be simplified into a single bi-directional route [ **AE** ] when Belle Ave to Beacon Cir [ **ae1** ] can be navigated by bus.

The B route can serve Mt Nittany Middle School and its surrounding neighborhoods for the first time [ **AF** ] when Brandywine Dr between Scenery Dr and Mt Nittany Middle School [ **af1** ] can be navigated by bus.

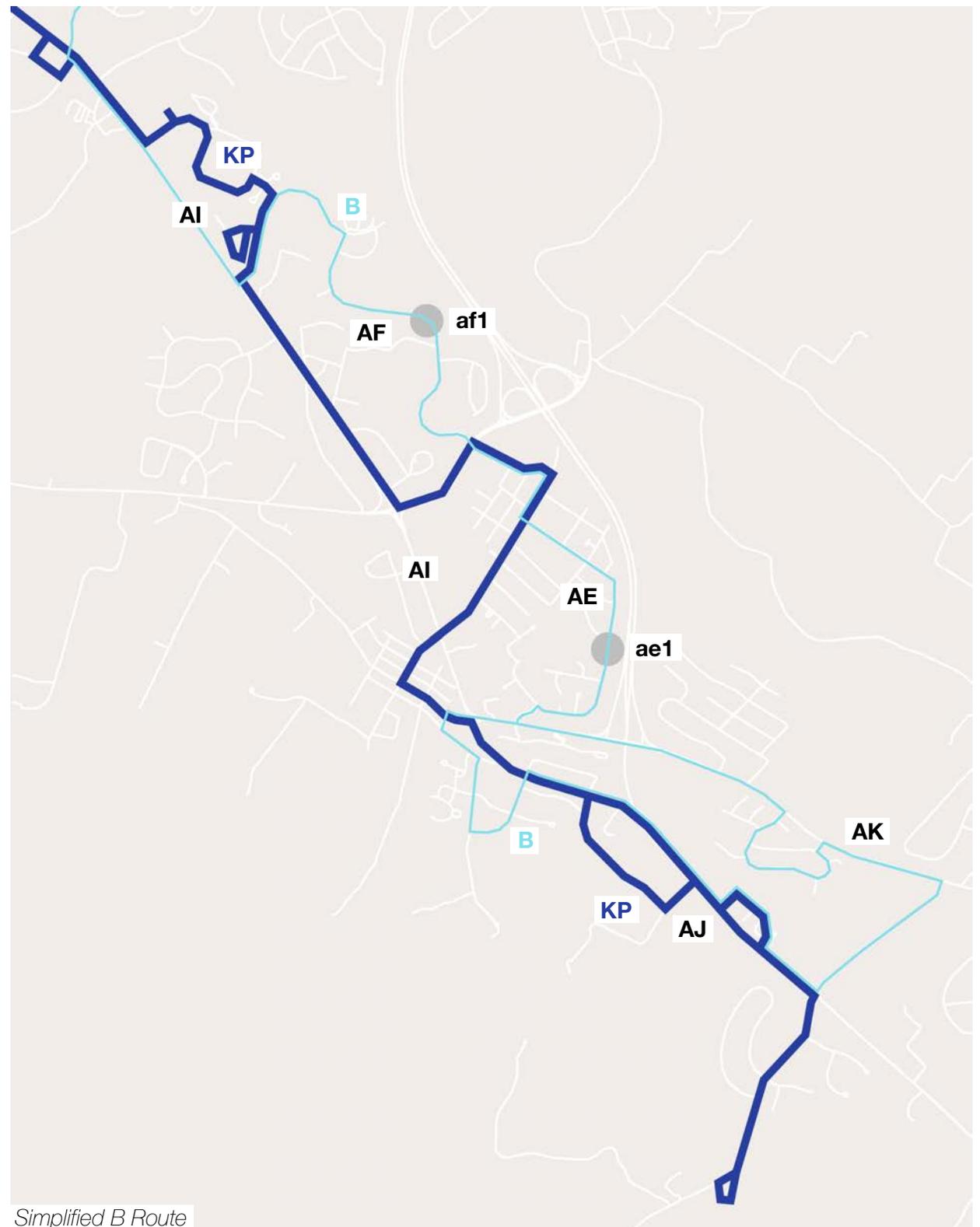
## OPPORTUNITIES & POSSIBILITIES

Without a loop, the A route could be extended north to Carnegie Dr [ **ag1** ] and Ghaner Dr [ **ag2** ] and even Graysdale [ **ag3** ] and Gray's Woods [ **ag4** ], making G route service between Stormstown and campus faster.

Faster A route service from Galen Dr and Amblerwood Way to campus could allow the W route to serve the area exclusively via Valley Vista Dr, bringing 30 minute frequencies closer to possible [ [see Increased Trunk Frequency](#) ]. Expanded pedestrian and bike connections between Galen Dr and Valley Vista Dr [ **AH** ] would be necessary for access to the W corridor.

As development occurs along S Atherton St between University Dr and Boalsburg, the KP route should be straightened and constrained to Atherton St to serve that new development better and provide faster service to downtown and campus [ **AI** ].

The ultimate goal for the B route should be to make the loop as small as possible. Potentially, the KP route could serve US 322 [ **AJ** ] and the B route could exclusively serve Earlystown Rd [ **AK** ].



*Simplified B Route*

# Other Notes

Stops on Blue Course Dr as close as possible to the Northland Center, on Vairo Blvd outside North Atherton Place, and near other commercial destinations on main roads will allow adjunct routes to better serve these commercial destinations without detouring through their parking lots.

An additional stop at Martin St and Blue Course Dr on the W and WE routes would allow riders to access The Park apartments without walking from the stops at the Northland Center, as many do today.

An additional stop on Toftrees Ave westbound outside The View and The Valley apartments would allow residents of those apartments to alight outbound HC buses before the bus takes a seven minute break at The Station.

Consider expanding the Loop and Link partnership to the K route to Cato Park because of the many ARL buildings on its route.

Hierarchic Color Scheme . System Map . Stop Info Panels

## **Network Legibility**

Increase access to the Community Service network with new branding emphasizing frequent corridors

# Hierarchic Color Scheme

Organize routes by frequency, span, reduced service status, and service area to improve network comprehensibility.

## EXISTING CONDITIONS

Different types of community services with distinct frequencies and spans are indistinct to riders.

There is no rider-facing frequent network to allow for trips without looking at timetables.

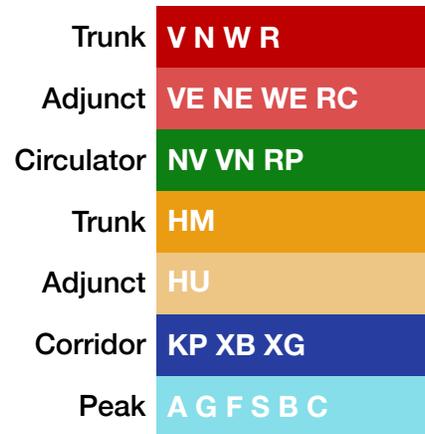
Frequencies and daily spans of service are further complicated by full and reduced service periods.

## NEW ADVANTAGES

Fewer colors allow for showing all routes downtown and on campus without overwhelming viewers.

Distinct colors clearly delineate route type, and related colors display the connections between adjunct routes and their trunks.

Trunk/adjunct colors cleanly separate full and reduced service, as well as frequency and span generally.



### Separate: Campus Services

Trunk, adjunct, and circulator colors correlate with routings on campus and downtown for a simpler system map [ see System Map ].

Services which come less frequently or only run during full service are shown with lighter colors so the always-running, frequent network is most visible.

## STRATEGY OPTIMIZATION

Clear route types allow CATA to teach development decision-makers about how they can use frequent transit to their advantage:

- Teach local municipal staff about frequent corridors with the system map so they can increase density, promote walkability, and decrease

parking around these corridors through zoning and subdivision and land development ordinances; and can encourage elected officials and developers to plan around these corridors

- Create relationships with local realtors to teach them about frequent corridors with the system map so they can use these corridors as selling points for homebuyers

Share route types in outreach to Penn State students to show which transit corridors are most convenient—generally which are most frequent—so they can make informed decisions about apartment rentals:

- Teach apartment landlords who own properties with good transit options how they can use frequent transit as a selling point
- Encourage local rental websites to include frequent transit corridors in their user interfaces
- Engage students directly at Penn State-sponsored housing fairs, in the HUB, or at transit stops to show the system map and information about frequent transit corridors
- Teach Penn State Student Affairs and other Penn State offices so they can inform students looking for off-campus living options. Encourage Penn State to include frequent transit corridors and the system map in mass emails about off-campus housing sent to students

## OPPORTUNITIES & POSSIBILITIES

Clear route types can help inform decisions about service changes:

- Maintaining a standard frequency on adjunct routes allows riders to understand the frequent network more easily
- Standardizing corridor routes through campus in the future, as long as convenience of movement is maintained, might improve comprehensibility
- Continuing to divide trunk routes as year-round service and adjunct routes as full service would improve corridor comprehensibility

Municipalities and developers in the Centre Region could use the frequent map to determine where density and redevelopment should be clustered. Homebuyers and renters should be encouraged to use the frequent map to ensure they will have a convenient commute.

## System Map

*Distribute a new system map showing the entire community service network, including campus and downtown.*

*Show information about spans and frequencies of services so the frequent network is accessible without timetables.*

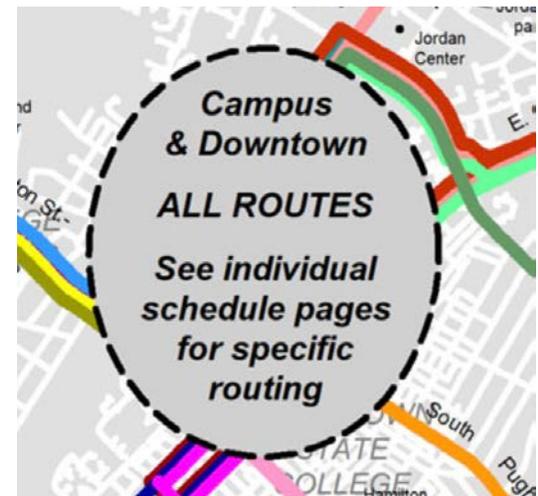
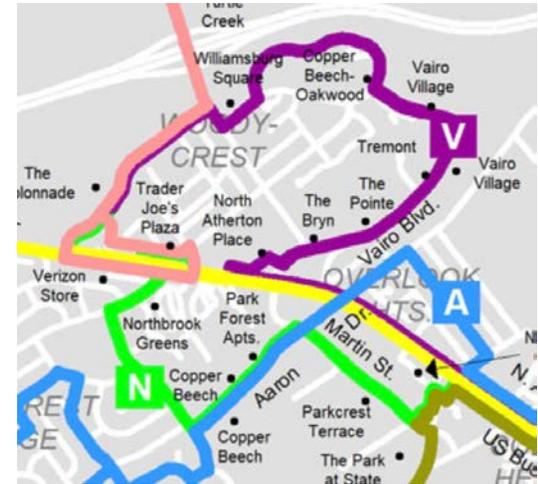
## EXISTING CONDITIONS

The current system map lacks the information required to understand the full system:

- All routes are shown with the same importance, even though some come every 20 minutes whereas others come four times a day
- The system map does not show how lines are routed on campus and downtown, making it hard to decide which bus to take on some corridors
- Some of the most frequent routes—express and campus routes—and routes which often expand the span of service—circulators including the NV, VN, and RP—are not shown on the system map
- There is no single page which shows an overview of all community service corridor locations, frequencies, and spans

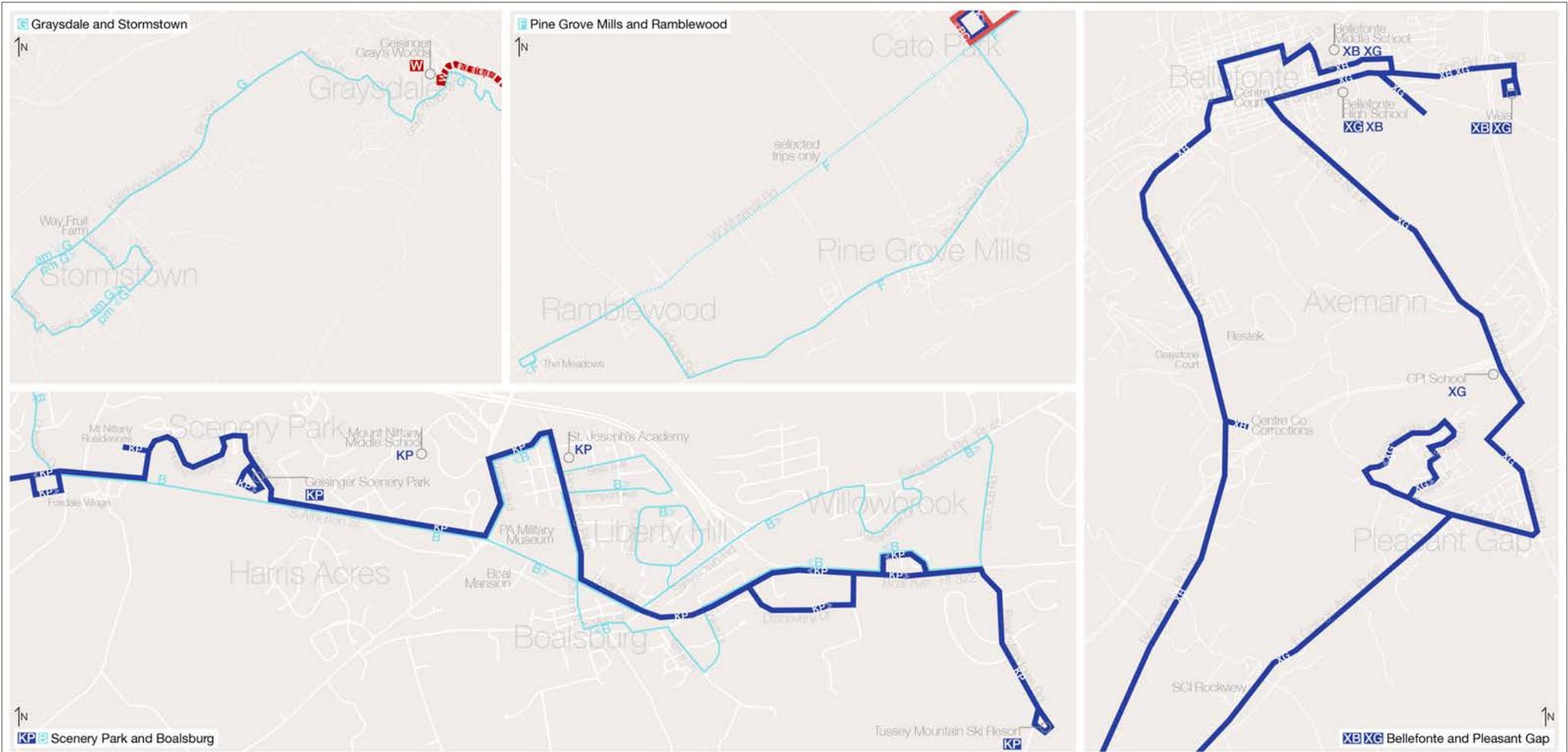
Detailed area maps do not prioritize information important to riders:

- Building outlines, stop numbers, etc. are superfluous information. They are better suited for Google Maps and neighborhood walking maps<sup>106</sup>



*Current system map, lacking campus and downtown routings, frequency differentiation, and adjunct or circulator routes*

<sup>106</sup> Metropolitan Transportation Authority, "MTA Neighborhood Maps: Queens," WalkNYC, accessed July 21, 2019.



# System Map

Fall 2019  
Spring 2020

**Mobile Apps**

Google Maps  
Point to point transit directions showing when and where to walk, ride, and transfer

MyStop Mobile  
Bus locations  
Real time arrivals  
Trip planning and alerts  
Walking Directions



**Other Services**

**Campus Service**  
Free routes serving Campus, Downtown, West Campus, Mt Nittany Medical Center, and Innovation Park

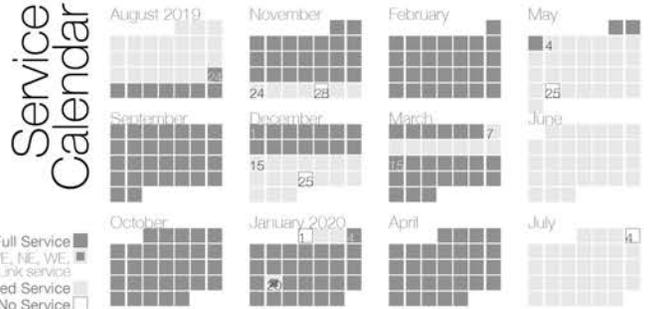
**Gameday Shuttle**  
\$2 routes serving Beaver Stadium, Downtown, and Free Parking on Penn State football gamedays

**CATACommute**  
Connects groups of commuters traveling from around the region to State College and Bellefonte  
[catabus.com](http://catabus.com) for details

**Contact Us**

[catabus.com](http://catabus.com)  
[cata@catabus.com](mailto:cata@catabus.com)  
814.238.CATA (2282)

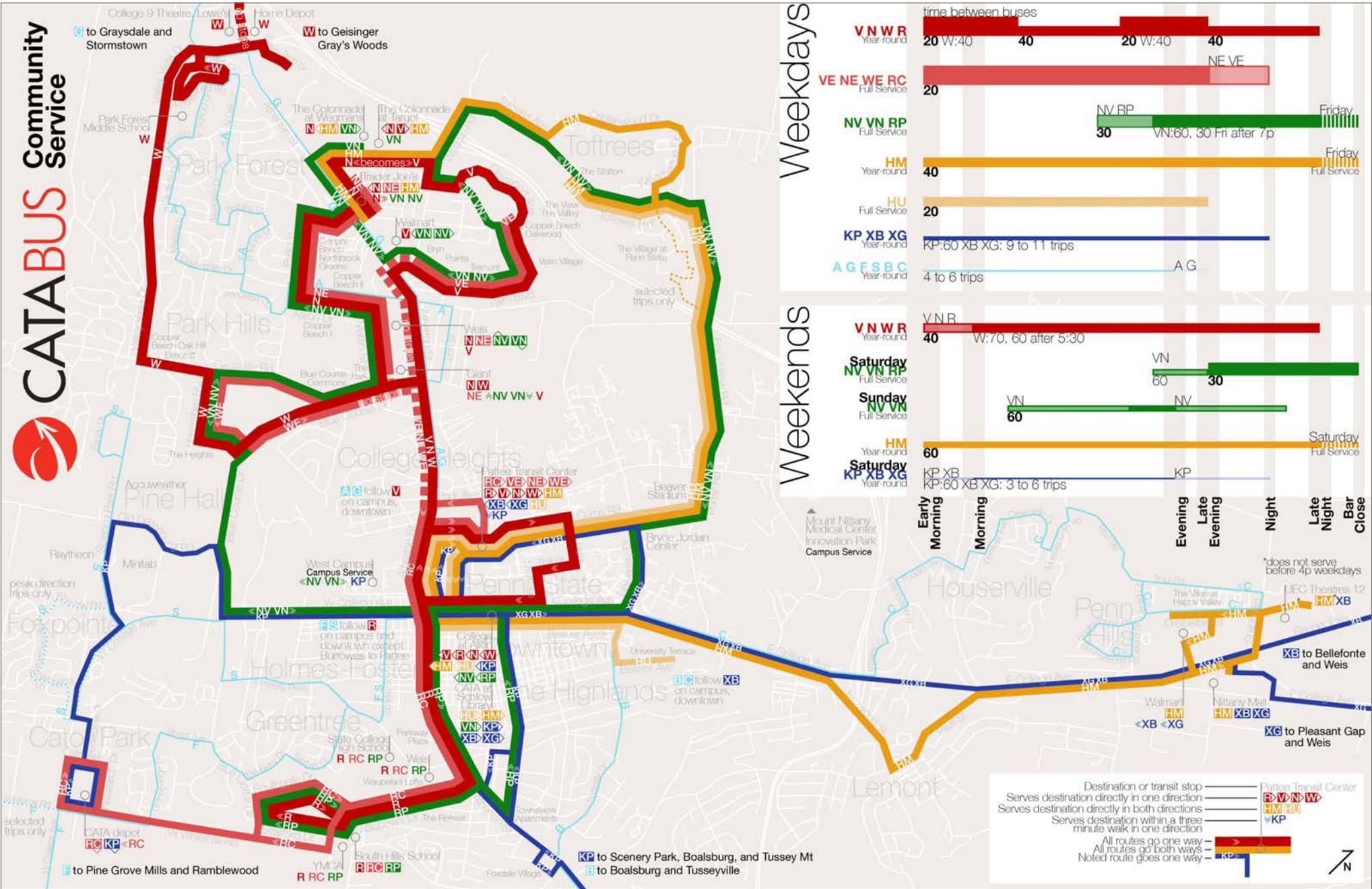
**Customer Service Center**  
108 E Beaver Ave  
State College, PA, 16801  
M-F: 7:30a-5:30p  
Sat: 9a-1p Sun: Closed



\*Campus Loops and Links are free to ride  
Unlimited pass, cash/coins (no change), tokens, Token Transit mobile app.  
Kids <40'; seniors w/ transit ID ride free; reduced fare details: [catabus.com](http://catabus.com)

Proposed CATA Community Service System Map: Outside. See appendix for full 11x17 inch and editable versions.

# CATABUS Community Service



Proposed CATA Community Service System Map: Inside. See [appendix](#) for full 11x17 inch and editable versions.



Current detailed area maps, showing superfluous information, and unlabeled, not frequency-differentiated, thin routes

- Though they are the most important part of the map, routes are hard to see because they are so thin
- Route lines do not show frequency, meaning routes coming every 20 minutes look the same as routes coming four times per day
- Routes are only labeled on the key, making it hard to remember which routes serve each corridor
- So much detail makes looking at a full system unmanageable, because one must zoom in so much to see anything
- Showing each route independently makes it almost impossible to show routes downtown and on campus in the same style

No system map variant is distributed as much as is warranted:

- There are only four bus stops with system maps posted for easy access
- There is no way to see system maps on any mobile app
- All variants but the most basic system map are hidden multiple convoluted clicks within the CATA website or are only shown in the Ride Guide, which most riders never see and which is hard or impossible to find on the CATA website

**There are so many system map variants that many are not completely updated for each service change.**

## NEW ADVANTAGES

Riders can more easily find the services they want to use: first-time riders can easily find trunk routes, commuters can optimize their trip on peak-only routes.

Riders can see all services which come soon, and their spans, at a glance.

Riders can see an overview of all services to decide how to get somewhere or to decide where to live.

Government officials and business leaders can use the frequent map to determine best locations for new civic spaces, developments, and businesses.

One system map with all routes means only one system map must be updated for service changes. **One system map, one set of corridor maps which double as stop info panels, and one set of detailed maps and timetables used by expert riders, could become the only maps CATA regularly updates, simplifying service changes significantly.**

## STRATEGY OPTIMIZATION

Post the new system map in as many places as possible to allow riders to memorize large portions of the system relevant to them:



*System maps should be easily accessible for spontaneous use*



*System maps posted onboard each bus*

- All buses should have system maps posted for viewing next to a container of system maps to take; instead of or as well as the ride guides currently offered
- All bus stops downtown and on campus should have a community service system map and a campus service map like the Pattee Transit Center stops currently do. Implementation should begin with all stops downtown and on campus which have shelters. At stops without shelters, system maps could be displayed on the exterior walls or in the lobbies of adjacent buildings until shelters are installed.

- All bus stops in the system with shelters should have a community service system map
- System map handouts should be given instead of or as well as ride guides to any community partners who currently receive ride guides

## **OPPORTUNITIES & POSSIBILITIES**

As the system map becomes an influential part of renting off-campus housing, their complex name's inclusion on the system map could be an incentive landlords receive for participating in the apartment pass program, or for including the pass in rent, rather than as an additional fee.

Explore service changes which would increase system map legibility without impairing mobility. It is especially important to simplify a route type's series of paths through campus and downtown. For example, combining the HC and UT routes in Fall 2019 will allow light yellow adjunct routes to have one already-standard route through campus and downtown. Changes should not happen if they negatively impact service and decrease mobility, even if they increase legibility.

As service changes, also explore adjusting thresholds for route types and therefore route colors to better align with routings on campus and downtown.

# Stop Info Panels

Create new stop info panels which condense route stop times to allow space for information about the entire corridor.

## EXISTING CONDITIONS

Current stop info panels are cluttered and lack context:

- There is no information about the buses running on the corridor or about where each route goes outside the corridor
- Tables of times obscure simple patterns, like that a bus comes every 20 minutes
- Unimportant information is emphasized unnecessarily by text formatting and placement

Corridor snapshots are not optimized for their best use:

- Their overall proportions make it impossible to show them on the long, thin info panels at each stop so they are necessarily poster-sized
- Routes show no regard to relative geometry. Reducing complexity by diagramming is good, but, for example, Waupelani Dr should not look like outbound is West to East when in

SATURDAY & SUNDAY:				
---	8:38	11:18	1:58	4:38
---	9:18	11:58	2:38	5:18
---	9:58	12:38	3:18	5:58
7:58	10:38	1:18	3:58	6:38

MONDAY - FRIDAY:				
---	8:41	10:21	12:01	1:41
7:21	9:01	10:41	12:21	2:01
7:41	9:21	11:01	12:41	2:21
8:01	9:41	11:21	1:01	2:41

These trips operate only on Fridays during FULL SERVICE. See the CATABUS Service Calendar for the exact dates of FULL SERVICE

**PM trips are in bold**

*Please have exact fare ready before you board.*  
*The scheduled departure times above are approximate as they are subject to traffic and weather conditions.*

**For the next departures from this stop in real time text CB398 to 321-123**

**For the next three departures from this stop in real time use this QR code.**

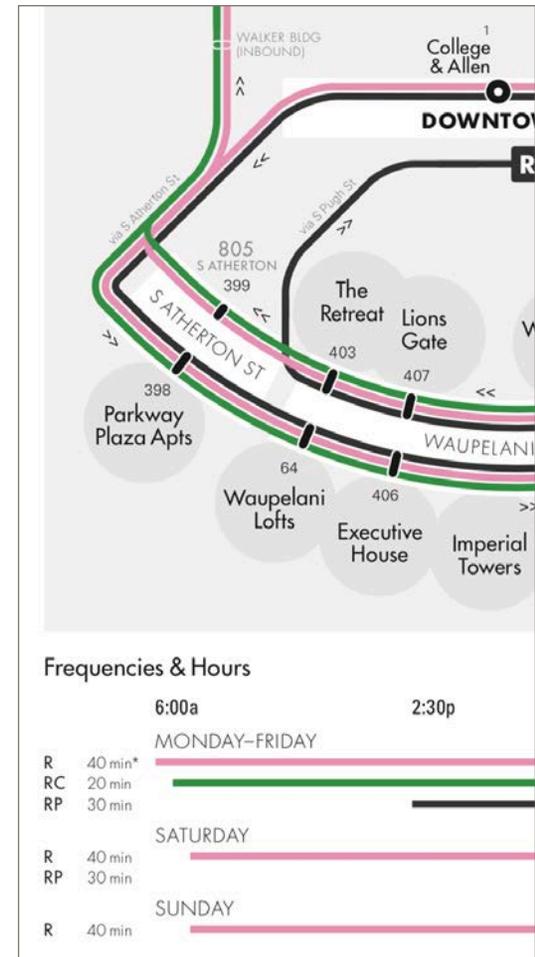


last revised: 7/30/2018 c297

238-CATA (2282) www.catabus.com

<http://realtime.catabus.com>

Current stop info panel, showing obscured 40- and 20 minute patterns and lack of graphic hierarchy



Current corridor snapshot, showing no regard to relative geometry, simple frequency and span information, and altered stop names, and lacking some stops along the routes shown

reality it is the opposite

- Frequency and span information is important, but is simple enough that all routes could be included on the same page on the system map
- Not all stops are shown within each corridor, and those shown do not use the official stop name, useful for real-time information
- At stops with corridor snapshot posters, ridership justifies a system map as well

## NEW ADVANTAGES

New info panels show the same information as the corridor snapshots and the current stop info panels do, combined on a single 6" by 24" panel. This frees poster frames which currently host corridor snapshots to host system maps instead.

The information is organized hierarchically, making it easy for riders to find the information they need, and information they didn't know they needed.

**The creation of these signs can be automated using Microsoft Excel and Adobe Illustrator from general transit feed specification data and blank corridor maps.**

The same headway notation is used on Campus Service posters, standardizing



*Current stop info panel, to be upgraded, and corridor snapshot, to be replaced with a system map, on Aaron Dr*

information formats for riders using both.

Corridor maps show stops with transfers to other routes and show portions of the corridor where other routes parallel nearby, for riders to discover more convenient commutes.

Because many corridors meet on campus and downtown, info panels use the full panel for displaying headways, spans, and stop timing. All stops on campus and downtown should have a system map posted in a shelter [ [see Bus Shelters](#) ], to replace the functionality of corridor diagrams elsewhere.

## STRATEGY OPTIMIZATION

Implement new stop info panels on the corridors with the most ridership first. Gradually upgrade all stop info panels to full-length 6" x 24" displays to allow all stops to show corridor maps.

To make official stop names more helpful, they should be changed to represent major destinations like apartment complexes rather than addresses. This will allow the stop info panels to show where apartment complexes are, like the corridor snapshots, without showing unofficial stop names.

Reduce and eliminate non-peak-only route schedules which do not follow a clock-face schedule, including frequencies like 35 minutes. Changes on the UT, P, and Saturday K timetables in Fall 2019 will leave only the Red Link, XB, XG, and weekend W routes to be changed.

Reduce and eventually eliminate schedules which do not repeat every hour. For example, transition 40 minute frequencies to 30 minutes [ [see Increased Trunk Frequency](#) ].

*Next four pages: sampling of stop info panels showing V, A, Colonnade Blvd and Atherton St corridors, and two panels on campus. See [appendix](#) for full 6 x 24 inch and editable versions.*



## Vairo Blvd at The Bryn Inbound stop 513

### Weekdays

@ :approx time past the hour



Year round

**6:33a to 11:53p**  
every 40 min  
@ :13 :53 odd hrs  
:33 even hrs

+

**7:13a to 10:33a**  
& **3:53p to 6:33p**  
every 20 min  
@ :13 :33 :53



Full Service

**7:11a to 9:51p**  
every 20 min  
@ :11 :31 :51



Full Service

**M-Th**  
**5:22p to 12:22a**  
every 60 min  
@ :22

F

**5:22p 6:22p &**  
**7:22p to 2:52a**  
every 30 min  
@ :22 :52

### Weekends



Year round

**7:13a to 11:53p**  
every 40 min  
@ :13 :53 odd hours  
:33 even hours



Full Service

does not run



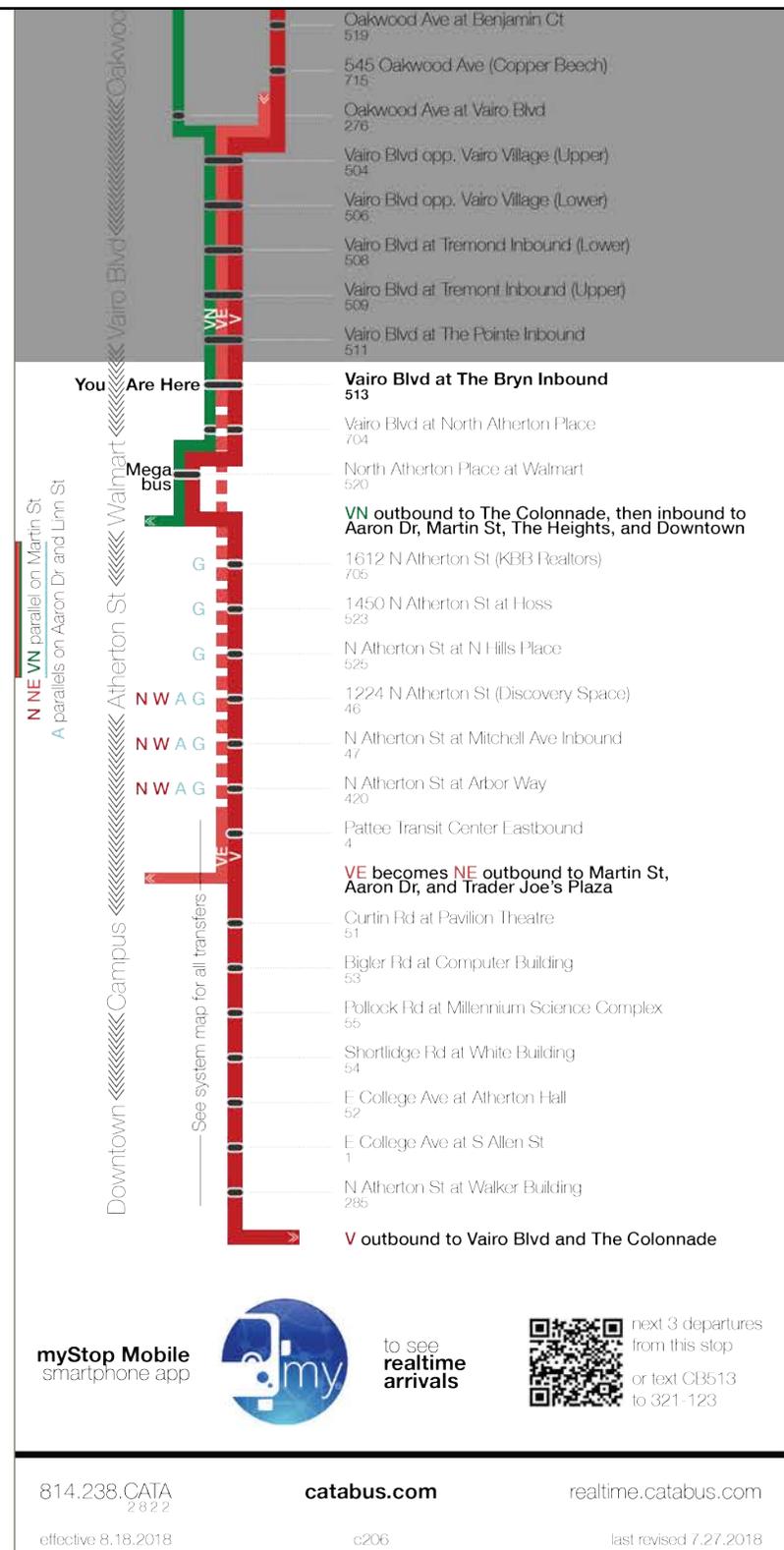
Full Service

**Sat**  
**5:22p 6:22p &**  
**7:22p to 2:52a**  
every 30 min  
@ :22 :52

**Sun**

**10:52a to 5:52p**  
every 60 min  
@ :52

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only; [catabus.com](http://catabus.com) for details



814.238.CATA  
2822

[catabus.com](http://catabus.com)

[realtime.catabus.com](http://realtime.catabus.com)

effective 8.18.2018

c206

last revised 7.27.2018



**Curtin Rd at the Pavilion Theatre**  
stop 51

# Weekdays

@ :approx time past the hour

<b>V</b> Year-round	<b>6:44a to 12:04a</b> <b>every 40 min</b> @ :04 :44 even hrs :24 odd hrs	+	<b>7:24a to 10:44a</b> & <b>3:24p to 6:44p</b> <b>every 20 min</b> @ :04 :24 :44
<b>R</b> Year-round	<b>6:22a to 12:22a</b> <b>every 40 min</b> @ :02 :42 odd hrs :22 even hrs	+	<b>7:02a to 10:22a</b> & <b>3:42p to 6:22p</b> <b>every 20 min</b> @ :02 :22 :42
<b>N</b> Year-round	<b>6:25a to 12:25a</b> <b>every 40 min</b> @ :05 :45 odd hrs :25 even hrs	+	<b>7:05a to 10:25a</b> & <b>3:45p to 6:25p</b> <b>every 20 min</b> @ :05 :25 :45
<b>W</b> Year-round	<b>6:18a to 8:58p</b> <b>every 40 min</b> @ :18 :58 even hrs :38 odd hrs	+	<b>8:58p to 11:58p</b> <b>every 60 min</b> @ :58
<b>HM</b> Year-round	<b>6:46a to 12:06a</b> <b>every 40 min</b> @ :06 :46 even hrs :26 odd hrs		
<b>HC</b> Full Service	<b>7:48a to 6:28p</b> <b>every 40 min</b> @ :08 :48 odd hrs :28 even hrs		<b>HC UT</b> do not run weekends
<b>UT</b> Full Service	7:17a 7:52a 8:22a 8:57a 9:27a 10:02a 10:32a 11:07a 12:12p 12:42p 1:17p 1:47p 2:22p 2:52p 3:27p 3:57p 4:32p 5:02p 5:37p 6:07p		
<b>K</b> Year-round	<b>7:27a to 9:27p</b> <b>every 60 min</b> @ :27		
<b>A</b> Year-round	7:34a 8:34a 4:07p 5:07p 6:07p		<b>A</b> does not run weekends
<b>G</b> Year-round	7:34a 12:05p 4:05p 5:05p		<b>G</b> does not run weekends
<b>F</b> Year-round	7:39a 8:46a* 11:24a 3:59p 5:04p		*8:46a: no service outbound past W Whitehall Rd at CATA stop <b>F</b> does not run weekends
<b>S</b>	6:55a 7:45a 4:15p 5:05p		<b>S</b> does not run weekends

RC VE NE WE weekday service from Pattee Transit Center  
NV VN RP night and weekend service from downtown

# Weekends

<b>V</b> Year-round	<b>7:24a to 12:04a</b> <b>every 40 min</b> @ :04 :44 even hours :24 odd hours		
<b>R</b> Year-round	<b>7:42a to 12:22a</b> <b>every 40 min</b> @ :02 :42 odd hours :22 even hours		
<b>N</b> Year-round	<b>7:45a to 12:25a</b> <b>every 40 min</b> @ :05 :45 odd hours :25 even hours		
<b>W</b> Year-round	9:58a 11:08a 12:18p 1:28p 2:38p 3:48p 4:58p 6:08p	+	<b>6:58p to 11:58p</b> <b>every 60 min</b> @ :58
<b>HM</b> Year-round	<b>8:06a to 12:06a</b> <b>every 60 min</b> @ :06		
<b>K</b> Year-round	<b>Sat</b> 7:27a 8:27a 12:27p 1:27p 4:27p 5:27p		

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only; catabus.com for details



**BL** Year-round    **RL** Year-round    **GL** Full Service

**Free, frequent service around campus and downtown**  
and to West Campus, stadium parking, the hospital, and Innovation Park

See poster in shelter for map and frequencies from this stop

myStop Mobile  
smartphone app



to see  
realtime  
arrivals



next 3 departures  
from this stop  
or text CB51  
to 321-123

814.238.CATA  
2822

catabus.com

realtime.catabus.com

effective 1.5.2019

c134

last revised 12.28.2018

NV VN RP night and weekend service from downtown

**N Atherton St at N Hills Place Inbound**  
stop 525

@ approx time past the hour

**Weekdays**

**V** Year-round 6:39a to 11:59p every 40 min @ 19 39 odd hrs 39 even hrs + 7:19a to 10:39a 3:59p to 6:39p every 20 min @ 19 39 odd hrs

**VE** Full Service does not stop

**G** Year-round 7:28a 8:50a 1:27p 5:27p 6:27p

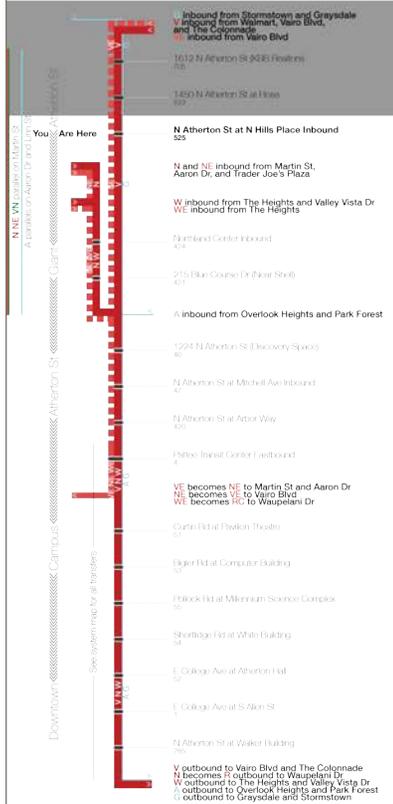
**Weekends**

**V** Year-round 7:19a to 11:59p every 40 min @ 19 odd hours 39 even hours

**VE** Full Service does not run

**G** Year-round does not run

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details



myStop Mobile 814.238.CATA 2112  
to 990 realtime arrivals  
QR code  
Call 314 departures from this stop or text C392 to 321 123

**North Atherton St at CVS Outbound**  
stop 8

@ approx time past the hour

**Weekdays**

**V** Year-round 7:01a to 12:21a every 40 min @ 21 41 odd hrs 21 even hrs + 7:41a to 11:01a 3:41p to 7:01p every 20 min @ 21 21 41

**N** Year-round 6:41a to 12:41a every 40 min @ 21 41 odd hrs 21 odd hrs + 4:01p to 6:41p every 20 min @ 21 21 41

**W** Year-round 6:37a to 8:37p every 40 min @ 17 37 odd hrs 37 even hrs + 9:21p to 12:21a every 60 min @ 21

**A** Year-round 7:56a 8:56a 4:29p 5:29p 6:29p **G** Year-round 7:52a 12:23p 4:23p 5:23p **A G** do not run weekends

**VE NE WE** do not stop weekdays  
**VE NE WE** do not run weekends

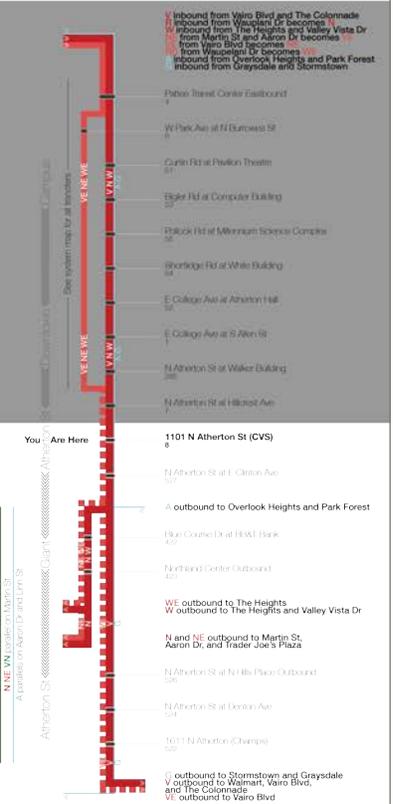
**Weekends**

**V** Year-round 7:41a to 12:21a every 40 min @ 21 odd hours 21 even hours

**N** Year-round 8:01a to 12:41a every 40 min @ 21 even hours 21 odd hours

**W** Year-round 10:13a 11:23a 12:33p 1:43p 2:53p 4:03p 5:13p + 6:21p to 12:21a every 60 min @ 21

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details



myStop Mobile 814.238.CATA 2112  
to 990 realtime arrivals  
QR code  
Call 314 departures from this stop or text C392 to 321 123

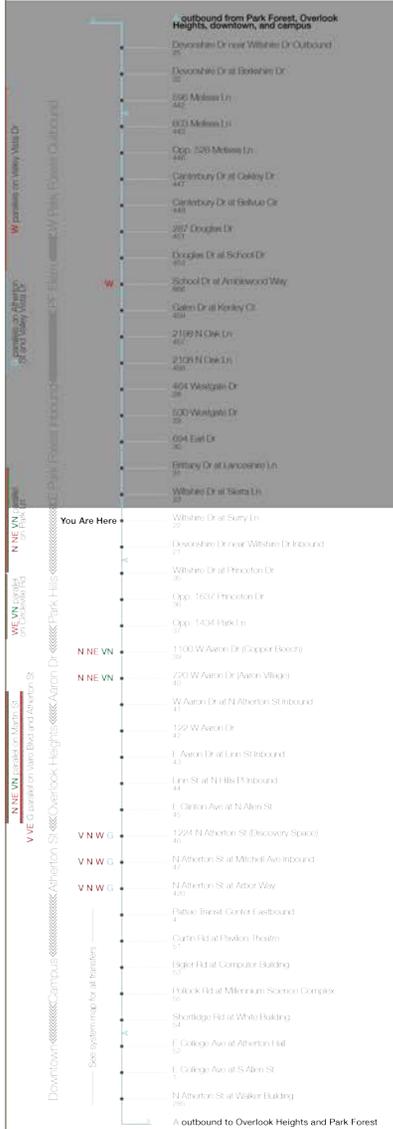
**Wiltshire Dr at Surry Ln Inbound**  
stop 22

@ approx time past the hour

**Weekdays**

**A** Year-round 7:17a 8:17a 9:17a 4:50p 5:50p 6:50p **A** does not run weekends

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details



myStop Mobile 814.238.CATA 2112  
to 990 realtime arrivals  
QR code  
Call 314 departures from this stop or text C392 to 321 123

**Trader Joe's Plaza Inbound**  
stop 497

@ approx time past the hour

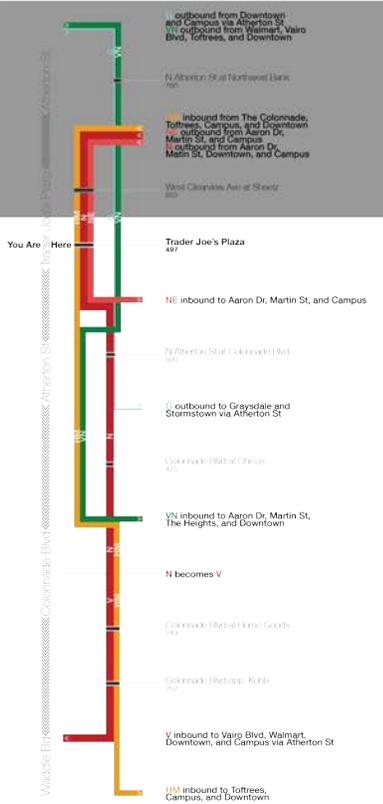
**Weekdays**

<b>N</b> Year-round	6:55a to 12:55a every 40 min @ 15, 35 even hrs	+	7:35a to 10:55a 4:15p to 6:55p every 20 min @ 15, 35 odd hrs
<b>NE</b> Full Service	7:44a to 7:24p every 20 min @ 05, 25, 45 & 8:04p, 8:44p, 9:24p		
<b>HM</b> Year-round	6:42a to 11:22p every 40 min @ 05, 45 even hrs 22 odd hrs	+	12:02a to 12:42a Fri nights during full service

**Weekends**

<b>N</b> Year-round	8:15a to 12:55a every 40 min @ 15, 35 even hours 35 odd hours		
<b>NE</b> Full Service	does not run		
<b>HM</b> Year-round	7:42a to 11:42p every 60 min @ 05	+	12:42a Sat nights during full service

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details



myStop Mobile 814 238 CATA 4142  
to 500 realtime arrivals call 314 parkers with the stop 814 238 CATA 4142  
or text 68197 81321 123

**N Atherton St at Chick-Fil-A Inbound**  
stop 499

@ approx time past the hour

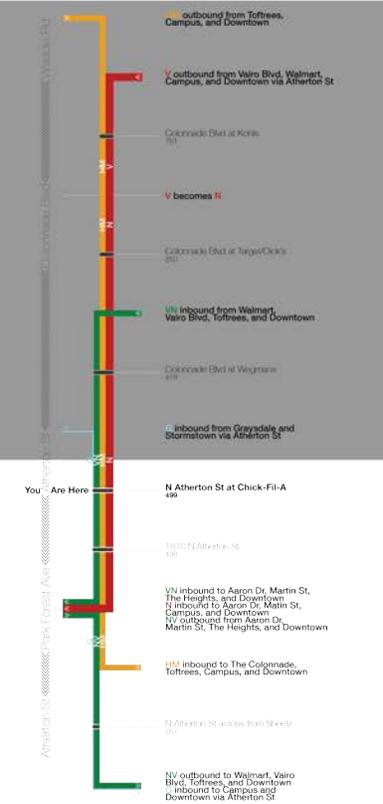
**Weekdays**

<b>N</b> Year-round	6:46a to 12:06a every 40 min @ 05, 45 even hrs 25 odd hrs	+	6:46a to 10:06a & 3:26p to 6:06p every 20 min @ 05, 25, 45
<b>HM</b> Year-round	7:13a to 12:33a every 40 min @ 13, 53 odd hours 33 even hours		*see trip ends at Trader Joe's Plaza, no service to downtown
<b>VN</b> Full Service	5:38p to 12:38a* every 60 min @ 25	+	5:28p, 6:28p, & 7:38p to 3:08a* every 30 min @ 05, 35
<b>G</b> Year-round	7:25a, 8:47a, 1:24p, 5:24p, 6:24p		G does not run weekends

**Weekends**

<b>N</b> Year-round	7:26a to 12:06a every 40 min @ 05, 45 even hours 26 odd hours		
<b>HM</b> Year-round	8:33a to 12:33a every 60 min @ 33		*see trip ends at Trader Joe's Plaza, no service to downtown
<b>VN</b> Full Service	7:38p to 3:08a* every 30 min @ 05, 35	+	11:08a to 6:08p* every 60 min @ 05

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details



myStop Mobile 814 238 CATA 4142  
to 500 realtime arrivals call 314 parkers with the stop 814 238 CATA 4142  
or text 68197 81321 123

**Pollock Rd at the Millennium Science Complex**  
stop 55

@ approx time past the hour

**Weekdays**

<b>V</b> Year-round	6:48a to 12:08a every 40 min @ 05, 45 even hrs 26 odd hrs	+	7:28a to 10:48a & 3:28p to 6:48p every 20 min @ 05, 25, 45
<b>R</b> Year-round	6:26a to 12:26a every 40 min @ 05, 45 odd hrs 26 even hrs	+	7:06a to 10:26a & 3:46p to 6:26p every 20 min @ 05, 25, 45
<b>N</b> Year-round	6:29a to 12:29a every 40 min @ 05, 45 odd hrs 26 even hrs	+	7:09a to 10:29a & 3:49p to 6:29p every 20 min @ 05, 25, 45
<b>W</b> Year-round	6:22a to 9:02p every 40 min @ 02, 42 odd hrs 22 even hrs	+	9:02p to 12:02a every 60 min @ 02
<b>K</b> Year-round	7:31a to 9:31p every 60 min @ 31		
<b>A</b> Year-round	7:38a, 8:38a, 4:11p, 5:11p, 6:11p		A does not run weekends
<b>G</b> Year-round	7:38a, 12:08p, 4:03p, 5:03p		G does not run weekends
<b>F</b> Year-round	7:43a, 8:50a* 11:28a, 4:03p, 5:08p		*15 min. no service outbound past 10:20am on Fri at CATA stop. F does not run weekends
<b>S</b> Year-round	6:59a, 7:49a, 4:19p, 5:09p		S does not run weekends

**Weekends**

<b>V</b> Year-round	7:28a to 12:08a every 40 min @ 05, 45 even hours 26 odd hours		
<b>R</b> Year-round	7:46a to 12:26a every 40 min @ 05, 45 odd hours 26 even hours		
<b>N</b> Year-round	7:49a to 12:29a every 40 min @ 05, 45 odd hours 26 even hours		
<b>W</b> Year-round	10:02a, 11:12a, 12:22p, 1:32p, 2:42p, 3:52p, 5:02p, 6:12p	+	7:02p to 12:02a every 60 min @ 02
<b>K Sat</b> Year-round	7:31a, 8:31a, 12:31p, 1:31p, 4:31p, 5:31p		

Please have exact fare ready before you board  
Full Service: PSU Fall and Spring semesters only, catabus.com for details

**CATABUS** Campus Service



Free, frequent service around campus and downtown  
and to stadium parking and Hastings Rd  
See poster in shelter for map and frequencies from this stop

myStop Mobile 814 238 CATA 4142  
to 500 realtime arrivals call 314 parkers with the stop 814 238 CATA 4142  
or text 68197 81321 123

## **OPPORTUNITIES & POSSIBILITIES**

Explore using electronic paper displays as stop info panels,<sup>107</sup> allowing for arrival countdowns and real-time locations of buses within the corridor. Arrival countdowns would allow for simplified frequency and span information.

routes as transit lines when transit is selected in Google Maps.

## Other Notes

Stickers on bus stop signs with frequent route icons could establish constant corridors in the minds of riders and non-riders, as the stickers on Campus Service bus stop signs do currently.

Upgrade bus location trackers to allow bus locations on apps to move in real time, like they do on the Campus Shuttle real time tracking. This would remove any guessing necessary to determine whether a bus is taking a break at a bus stop or stopped at a traffic light; or whether the bus is moving but the location tracker has not updated, increasing rider satisfaction.

If possible, share shapefile data with Google Maps Transit for all non-peak-only bus routes to show all these

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<sup>107</sup> ["Papercast," Papercast, 2019.](#)

Apartment Pass Program . Event Road Closures . Infrastructure Improvement Negotiations . Bus Shelters . Other Notes

## **Organization Cooperation**

Empower associated organizations and municipalities to improve transit by advocating for rider priorities

# Apartment Pass Program

*Create apartment passes which allow unlimited rides on the entire CATA system and phase out existing single corridor-only passes.*

*Create ways residential towers downtown can support Loop service.*

## EXISTING CONDITIONS

Corridor passes offer riders access to 20% of the CATA system at 80% of the cost of unlimited service to CATA.<sup>108</sup> Riders with corridor passes would use a system-wide unlimited pass mostly to commute on their apartment's corridor routes during the peak, but a system-wide unlimited pass might allow them stop bringing a car to State College for the few times—probably off-peak—they need to travel elsewhere.

Residential towers downtown do not contribute to transit funding directly, but residents use White and Blue Loop

service extensively, leading to severe overcrowding.

## NEW ADVANTAGES

Offering system-wide unlimited passes rather than corridor unlimited passes to apartment lessees would increase off-peak ridership, which is less expensive for CATA to provide,<sup>109</sup> and increase rider satisfaction. CATA could charge slightly more for system-wide rather than corridor passes, increasing revenue.

## STRATEGY OPTIMIZATION

Introduce system-wide apartment passes as a premium apartment amenity, potentially at a discounted rate for parity with corridor passes at first, and slowly phase out corridor passes, transitioning all apartment landlords to system-wide passes.

**Work with the State College Borough to revise parking minimum zoning regulations, to allow developers to reduce or eliminate parking in exchange for funding of some amount of White Loop service.**

## OPPORTUNITIES & POSSIBILITIES

Advocate for local ordinances which mandate that all landlords decouple parking prices from rent<sup>110</sup> and provide transit passes to all renters, including landlords of housing on Southgate Dr and Aaron Dr, many of which were built before the apartment pass program was mandatory for new development.

## Event Road Closures

*CATA, in coordination with the State College Borough and Penn State, should create guidelines for which streets should be closed for different types of event, to minimize transit route changes.*

## EXISTING CONDITIONS

Moving bus routes for festivals and parades interrupts regular riders' commutes and decreases the chance

<sup>108</sup> A reference to the Pareto Principle. "Pareto Principle," Wikipedia, June 10, 2019.

<sup>109</sup> Alon Levy, "Base Train Service is Cheap, Peak Train Service is Expensive," Pedestrian Observations, January 22, 2018.

<sup>110</sup> Angie Schmitt, "Landlords in Seattle Can't Force Renters to Pay for Parking Anymore," Streetsblog USA, April 3, 2018.

event attendees will use transit to get to the event.

**Changes to routes for events are not abundantly clear to riders, and are sometimes not clear even to bus operators.**



*During the 2018 PSU Homecoming Parade when Curtin Rd and College Ave were closed, buses were rerouted on Park Ave, but eastbound buses could not stop without temporary bus stops; operators and riders had little information*

## NEW ADVANTAGES

During events with significant traffic, like concerts and football games, fast, reliable bus service, running on the same network as riders use daily and have memorized, with stops close to the event, gives event attendees a viable alternative to driving, even if temporary bus lanes increase vehicle congestion slightly.

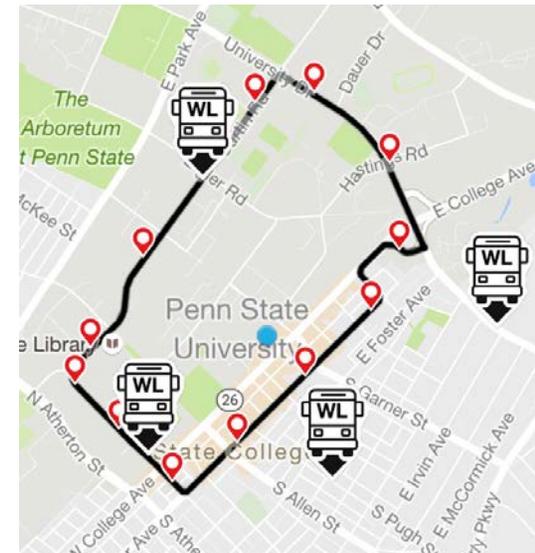
## STRATEGY OPTIMIZATION

Streets should be prioritized based on where road closures have the most impact to transit:

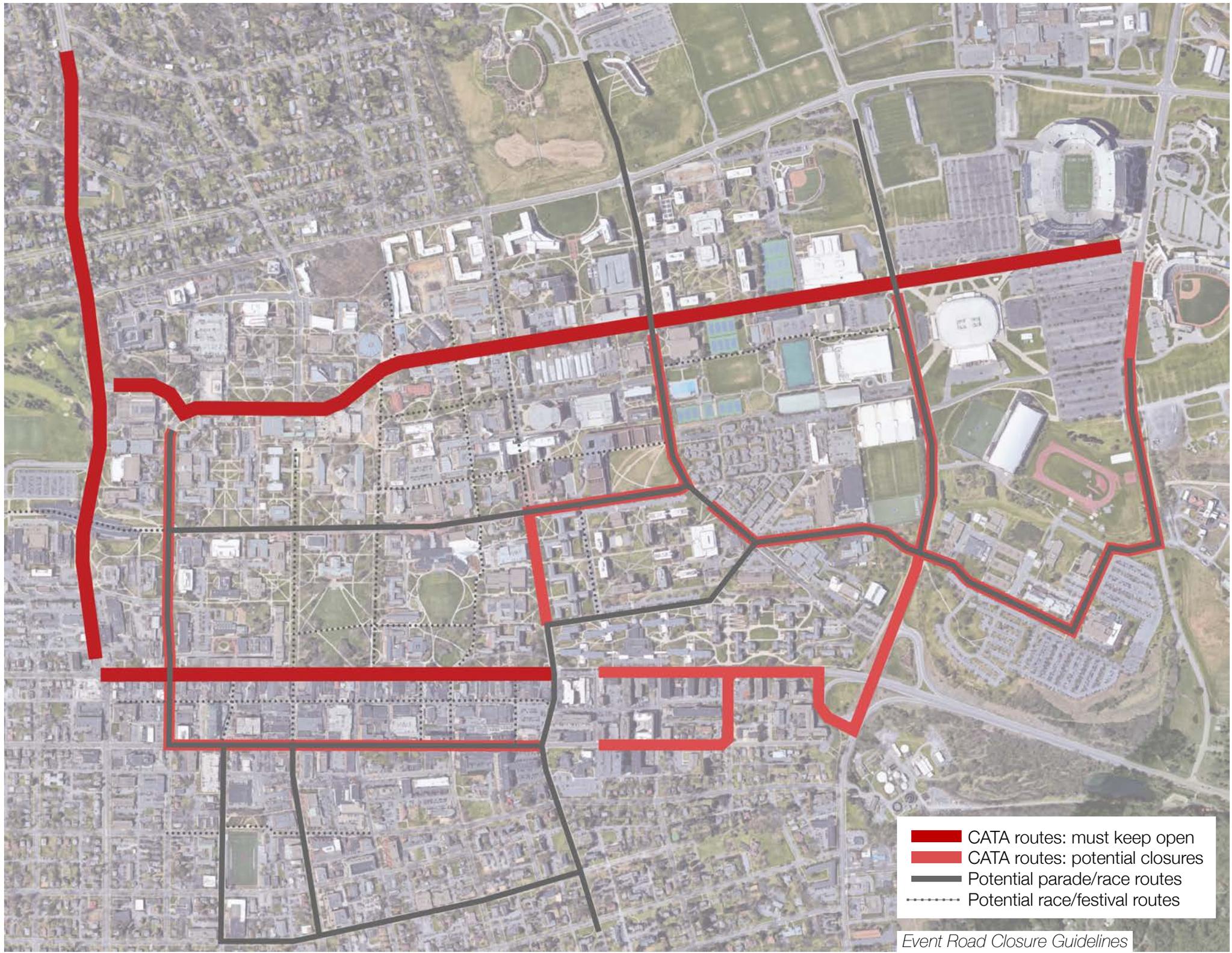
- **Curtin Rd, College Ave, and Atherton St should be kept open at all times, because each carries a significant number of buses, stops are the busiest in the system, and there are no comparable alternative routes, especially with any stop infrastructure**
- Beaver Ave should be closed only when absolutely necessary because of stops with significant ridership and no good alternate routings. Beaver Ave is only a candidate for closings because it can be closed to allow parades downtown, without the closure of College Ave. With the completion of a College Ave or Beaver Ave Transitway [ [see Bus Lanes](#) ], parades should use the other

street, allowing for undisturbed transit operations

- Burrowes Rd can be closed more easily because Atherton St provides a nearby alternate routing, although Atherton St does not have southbound stop infrastructure to replace stops with high ridership on Burrowes Rd. An Atherton Transitway [ [see Atherton Transitway](#) ] would create stops southbound on Atherton St and would allow all transit on Burrowes Rd to move to Atherton St permanently, allowing road closures



*White Loops detouring through residential streets during a Beaver Ave emergency closure on October 7, 2016. Closure of Beaver Ave, and this detour, should be avoided.*



-  CATA routes: must keep open
-  CATA routes: potential closures
-  Potential parade/race routes
-  Potential race/festival routes

on Burrowes Rd without transit impacts

- Roads in east campus including University Dr, Hastings Rd, Bigler Rd, Pollock Rd, and Shortlidge Rd should be the first roads with transit impact closed, as they have many alternative routings and host stops with fewer passengers than elsewhere on campus

There are three types of events which should be treated differently:

- Parades require a long, single route on paved streets with staging areas at the beginning and a place for vehicles to exit at the end of the route. Road closures in east campus, on Beaver Ave, and on Burrowes Rd should be discouraged but generally accepted
- Races and walks require long, single routes on streets and wide pedestrian paths. Road closures in east campus and on Burrowes Rd should be discouraged but generally accepted
- Festivals require any assortment of routes on streets or wide pedestrian paths. Small festivals should have no road closures impacting CATA, and large festivals like Arts Fest should have minimal road closures impacting CATA

Use permanent and temporary bus lanes to maintain bus speed and reliability while maintaining proximity to

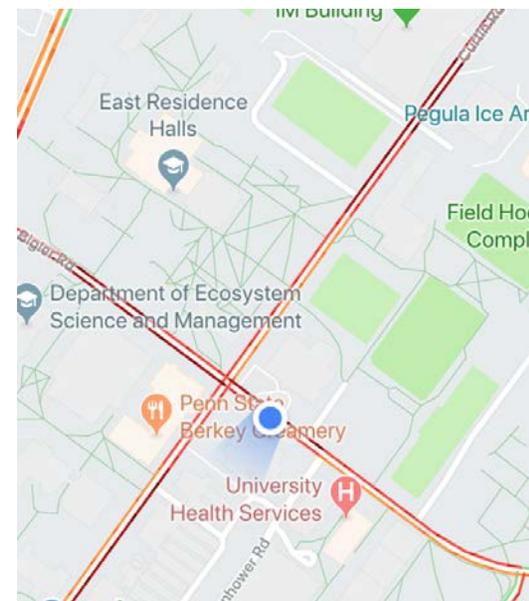
major events. Permanent bus lanes on Curtin Rd and temporary bus lanes southbound on Bigler Rd, Pollock Rd, and Shortlidge Rd would speed buses around the entire CATA network during football games and Bryce Jordan Center events. Roads which cross parade or race routes should become temporarily bus-only or have temporary bus lanes to allow buses to cross the route during gaps in the race or parade, without making buses wait behind queued cars.

**When stops are moved, place free-standing signs conspicuously on the sidewalk next to the stop explaining the change and the best alternatives, at least one week before the change.** Place temporary bus stop signs at locations on alternate routings to replace each stop lost during road closures.

Negotiate with Penn State Athletics to allow Blue and White Loops—and potentially all routes—to travel on their normal routings near Beaver Stadium during football games, increasing rider convenience and familiarity with routings. Buses could travel slowly, to integrate with the pedestrians using the Curtin Rd cartway. Loops could replace the Downtown Football Shuttle, and gains in ridership and rider satisfaction would be worth the reduction in revenue. Currently, even Uber pickups happen on Hastings Rd, closer to the stadium than either Loop travels. If



*Buses stopped by football game congestion, impacting the entire system*



*Congestion from an October 20, 2018 Bryce Jordan Center event delayed buses with commuters and event attendees by 20 minutes; temporary bus lanes would have provided an alternative means of travel to the event*

potential terrorism is an issue, temporary or permanent retractable bollards could be installed to allow only transit vehicles access.<sup>111</sup>

## OPPORTUNITIES & POSSIBILITIES

Advocate for an ordinance in State College Borough which requires approval by CATA for road closures impacting transit routes, similar to the current requirement that adjacent businesses agree to road closures.



*A sign at Beaver Stadium for an Uber pickup zone on Hastings Rd during football games. Blue and White Loops should have signage and stops at least as close as Uber does to the stadium.*

# Infrastructure Improvement Negotiations

*High political support for transit and low costs of improvements allow CATA to be more forceful in its requests to developers, municipalities, Penn State, and PennDOT for bus route improvements and bus stop amenities.*

## EXISTING CONDITIONS

Political leaders and to some extent developers generally want to support transit improvements, but do not know that makes transit work best. This can be true for bus stop amenities, but is especially true for fundamentally what makes a good bus route: walkability, density, proximity, and especially linearity.<sup>112</sup>

Improvements recommended by CATA are generally reactionary band-aids, like stops in parking lots and pedestrian connections, rather than

suggestions for creating the type of development which allows transit to thrive.

## STRATEGY OPTIMIZATION

**Review development plans earlier—before the sketch plan phase—to advocate for changes along routes to speed buses:**

- Advocate for dense development along existing high frequency transit corridors, with retail entrances oriented toward— and adjacent to main streets, rather than behind parking
- In new developments, advocate for straight routes for transit which connect to the existing CATA network
- Propose locations where intersections with two-way stops can be reconfigured to give priority to streets with transit routes<sup>113</sup>

When reviewing plans for bus stop changes, ask for the optimal condition bus stop improvements could provide, then negotiate based on capital cost:

- Advocate for shelters at almost every stop not entirely surrounded by

<sup>111</sup> Jarrett Walker, “How (Not) to Wreck Your Transit System: Downtown Business Edition,” Human Transit, February 3, 2017.

<sup>112</sup> Jarrett Walker, “The Transit Ridership Recipe,” Human Transit, 2019.

<sup>113</sup> Jarrett Walker + Associates, “Philadelphia Bus Network Choices Report: Improving Speed and Reliability: The Role of City Leadership,” Southeastern Pennsylvania Transportation Authority, June 2018, 48.

single-family housing [ [see Bus Shelters](#) ]

- Advocate strongly against bus pull-offs, except where buses are scheduled to wait for extended periods<sup>114</sup>
- Advocate for median treatments which disallow cars from swerving around stopped buses by entering the opposing traffic lane. This will improve safety for car drivers and for transit riders who cross the street in



*Threadneedle St in Central London with median treatments to disallow cars from passing stopped buses; [Google Maps](#)*

## **BUS PULL-OFFS DO NOT DECREASE DELAY**

**The Martin St corridor might be one of the most likely candidates for bus pull-offs in CATA's service area. However, an average of only 56.25 cars were delayed by buses over four, hour-long, single-direction, single-stop observations at morning and evening peaks.<sup>115</sup> With a standard vehicle occupancy of 1.7,<sup>116</sup> 95.625 people on average were delayed in cars, equivalent to two moderately crowded buses. If all six or more CATA buses in each direction passing each stop on Martin St each peak hour, carrying 300 or more people total, were forced to re-enter mixed-traffic lanes, significantly more people**

**would be delayed than the number delayed today.** All-door boarding [ [see Proof-of-Payment & All-Door Boarding](#) ] would significantly decrease car delay caused by dwelling buses, further diminishing the benefits of bus pull-offs. Most bus pull-offs on campus can be maintained because the introduction of bus lanes [ [see Bus Lanes](#) ] will eliminate delay buses face from re-entering mixed-traffic lanes. Bus stops with adjacent parallel parking lanes should have bus stop bulb-outs,<sup>117</sup> rather than pull-offs into the parking lane, to allow buses to remain in the mixed-traffic lane and to allow extra sidewalk space for waiting transit users.

<sup>114</sup> Xiaodong Liu, Yao Yang, Meng Meng, & Andreas Rau, "Impact of Different Bus Stop Designs on Bus Operating Time Components," *Journal of Public Transportation* 20(1):104-118, DOI:10.5038/2375-0901.20.1.6, February 2017.

<sup>115</sup> McCormick Taylor, "Northland Area Mobility Study Report," Ferguson Township, May 2019, 10.

<sup>116</sup> "Average Vehicle Occupancy Factors for Computing Travel Time Reliability Measures and Total Peak Hour Excessive Delay Metrics," Federal Highway Administration, April 2018, 1.

<sup>117</sup> "In-Lane Sidewalk Stop," *Transit Street Design Guide*, National Association of City Transportation Officials, April 2016.

front of stopped buses and who would not expect a car going the wrong way in the far lane. **Bus stops for immediate consideration include:**

- **Burrowes Rd southbound at Westgate Building, especially because of a crosswalk directly in front of the stop**
- 805 S Atherton St and S Atherton St at Pizza Hut, with potential removal of the center turn lane directly in front of the bus stops
- S Burrowes St at the James Elliott Building



*Newly upgraded stop on N Atherton St at N Hills Pl, with concrete pad and bench but no shelter*

Advocate for temporary improvements for transit riders during construction projects:

- Where two lanes of mixed traffic are merged into one, use one of the two lanes—the one which leads directly into the single lane, rather than the one which requires vehicles to merge—as a bus lane leading up to the single-lane section, allowing buses to bypass most of the traffic. For example, these lanes could be used for utilities and resurfacing work on Atherton St and for unloading residential tower construction equipment on College Ave
- Demand significant capital improvements or commitments when compromising for construction against the interests of riders. For example:
  - Removal of the pedestrian connection next to Curtin Hall to Blue and White Loop stops from the majority of East Halls during Martin Hall construction
  - Removal of the University Club stop for years due to residential tower construction across College Ave
  - Removal of N and W stops on Blue Course Dr for Northland Area Mobility Study bike improvements<sup>118</sup>



*Congestion created by a residential tower construction-related lane closure on College Ave. A temporary bus lane before the closure would allow buses to bypass the congestion.*



*Road construction blocking the Atherton St at Walker Building bus stop, without alternatives for— or future benefits to riders*

<sup>118</sup> McCormick Taylor, “Northland Area Mobility Study Report,” Ferguson Township, May 2019, 24.



*Removal of the College Ave at University Club stop for potential impacts to traffic from residential tower construction across the street, without substantial future benefits to riders*



*Prolonged sidewalk and bus stop closures along N Atherton St due to construction; few future benefits to riders*

## OPPORTUNITIES & POSSIBILITIES

**Explore implementation of near-level boarding at high-ridership stops to decrease dwell times, especially downtown and on campus.**

## Bus Shelters

**CATA should establish a goal to install a shelter at every stop on campus and downtown, at every inbound stop with any development more dense than exclusively single-family housing, and at every outbound stop on routes which serve commercial destinations farther outbound.**

## EXISTING CONDITIONS

Only about 78 stops in the CATA system have bus stop shelters or overhangs from buildings directly adjacent to stops.

Shelters provide so much benefit at so little cost that any bus stop with more than 2.5 weekday boardings should receive one.<sup>119</sup>

## NEW ADVANTAGES

All new developments which are not small, exclusively single-family home developments should be required to install shelters at every stop covered by CATA's new shelter goal.

CATA should seek funding to vastly expand the number of shelters currently installed.

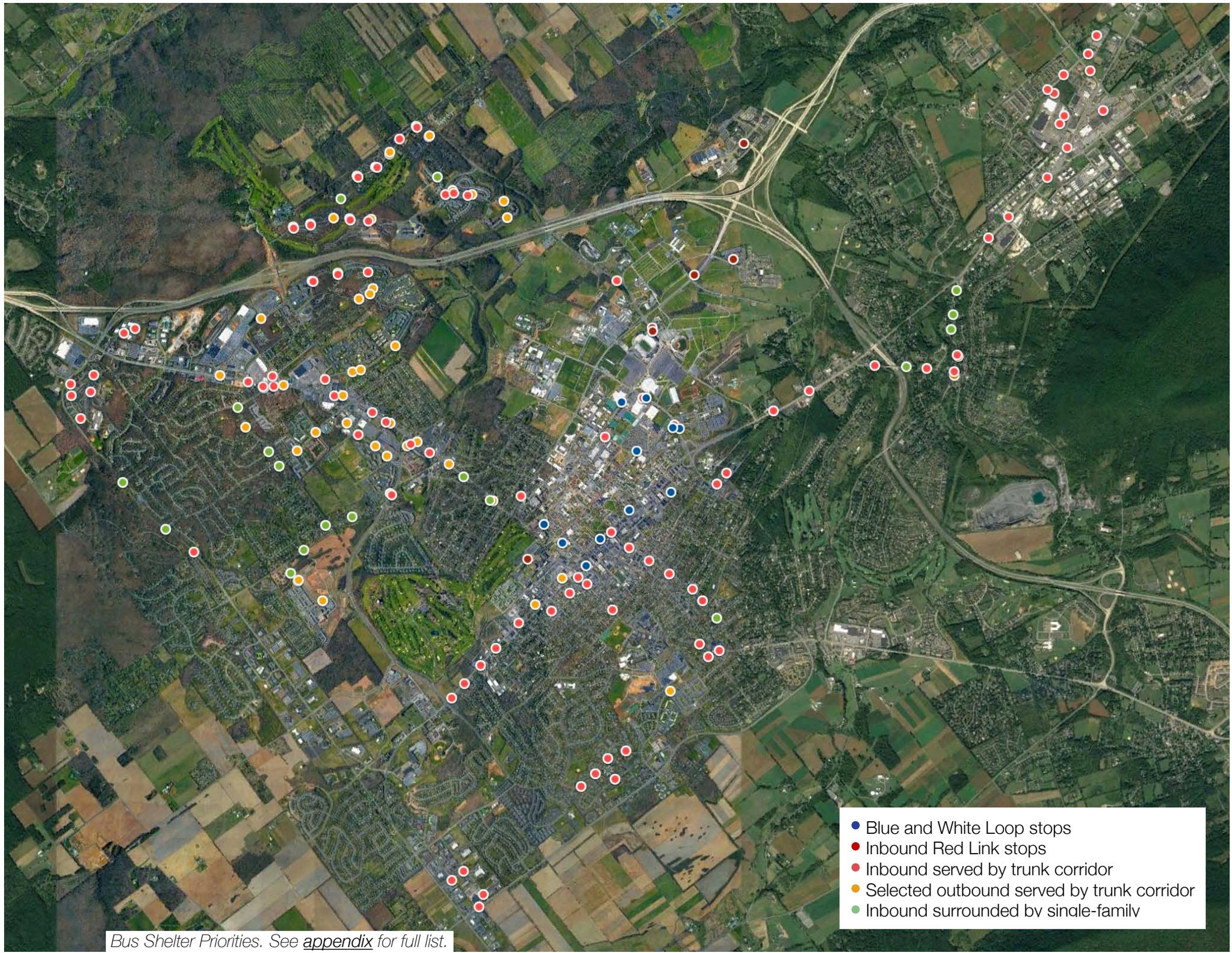
## STRATEGY OPTIMIZATION

Until the goal is met, shelter additions by CATA should be prioritized based on boardings and direction. Generally: (approximate number of stops in group)

- Blue and White Loop stops<sup>120</sup> (13)
- Inbound Red Link stops (5)
- Stops downtown and on campus and inbound stops served by trunk, adjunct, or circulator routes [ [see Hierarchic Color Scheme](#) ] with nearby non-single-family housing development (90)
- Select outbound stops served by trunk, adjunct, or circulator routes which serve commercial destinations farther outbound (46)
- Inbound stops served by trunk, adjunct, or circulator routes with only single-family housing development nearby (18)

<sup>119</sup> Alon Levy, "Little Things That Matter: Bus Shelter," *Pedestrian Observations*, April 12, 2019.

<sup>120</sup> "Centre County Long Range Transportation Plan 2044," Centre Regional Planning Agency, July 31, 2018, X-12.



Bus Shelter Priorities. See [appendix](#) for full list.

- Other stops, with a preference for inbound stops with higher frequency routes surrounded by more dense land uses (567)

All shelters should include a poster frame for a system map.

All shelters, or potentially all bus stop signs [ see [Stop Info Panels](#) ], should also receive real-time bus location information, as the benefit provided makes these even easier to justify, at only 1.25 weekday boardings per stop.<sup>121</sup>

## OPPORTUNITIES & POSSIBILITIES

Explore introducing zoning regulations which encourage new developments, especially downtown and on campus, to include climate-controlled sheltered space with real-time bus location information adjacent to bus stops in lobby areas open all the time, as the CATA office at Schlow does today. This should not be a substitute for shelters from rain directly adjacent to stops, as riders must be visible as their bus approaches to signal the operator to stop.

## Other Notes

Negotiate with the State College Borough to create a free transit program in parity with the free parking program downtown during winter break and other holidays. Additionally, businesses which offer parking validation should also offer transit fare validation.

Negotiate with the State College Borough and other municipalities to ensure bus stops, including the vicinity of where the rear door stops, are

cleared of snow with increased enforcement.

Advocate for adoption of a priority merge rule, to mandate that mixed traffic yields to buses exiting bus pull-offs.<sup>122</sup> Post signs at all bus pull-offs notifying car drivers that they must yield to merging buses.

Work with Penn State to turn the Blue Loop or White Loop into the Parents' Weekend Trolley and other special event shuttles on campus, with additional signage and tour guides on each bus. The route should remain unchanged, to allow frequent users to ride the Loop as they normally would.



*A free transit program should be created to match the free parking program downtown*



*A White Loop at S Burrowes St at the James Elliott Building: the sidewalk around the rear door is covered by snow*

<sup>121</sup> [Alon Levy, "Little Things."](#)

<sup>122</sup> ["Stops, Spacing, Location, and Design," Federal Transit Administration, U.S. Department of Transportation, March 16, 2016.](#)



*A Parents' Weekend Trolley Stop. Many stops are located directly adjacent to existing Blue Loop stops.*

When a second CATA bus depot is warranted, explore locating it near the OPP facilities on campus, to be near the center of the CATA system. Combination of the Loops and Links and Campus Shuttles [ [see Campus Network](#) ] could begin a partnership with PSU Transportation.

Work with the Central PA 4<sup>th</sup> Fest to find sponsors to fund Blue Loop service during the event for movement

between the festival, parking, and downtown, on the normal route [ [see Event Road Closures](#) ].

Work with the State College Area School District and Bellefonte Area School District to travel to middle and high schools and email parents to pitch the benefits of transit and the discounted youth pass.

Projects Matrix

# Implementation

Achieve substantial ridership increases through incremental improvements in partnership with community organizations

# Projects Matrix

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Boarding Policies</b>	Implement proof-of payment with fare inspectors		Fall 2020 Semester	Net-positive	Very High	Yes
	implement all-door boarding		With proof-of payment	Revenue-generating	Very High	Yes
	Potentially upgrade Automatic Passenger Counters		Before proof-of-payment	Low capital cost	Medium	
	Reduce farebox-necessary payment		With proof-of payment	Neutral	High	Yes
	Create a fare-free zone on campus and downtown		With- or after proof-of-payment	Revenue-generating	High	Yes
<b>Bus Layout</b>	Remove two seats from existing 40 foot buses		Short-term	Low capital cost	Medium	Yes
	Purchase new buses with more open space and fewer chokepoints, low windows, and rear doors which slide out and to the side		Medium-term	Neutral	High	
	Purchase 3 door 40 foot buses, eventually with a door at the rear end	Bus Manufacturers	Long-term	Medium additional capital cost	Very High	
	Purchase 4-5 door articulated buses		Medium-term	Low additional capital cost	High	
	Increase capacity by creating announcements and by folding aisle-facing seats		Short-term	Neutral	High	Yes

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Bus Layout</b>	Track and reduce the amount of time Loop buses spend as discharge-only		Medium-term	Net-positive	Medium	
	Add stop request buttons to poles		Medium-term	Low capital cost	Low	
	Purchase automatic wheelchair securement devices		Long-term	Medium capital cost	Low	Yes
	Explore vertical bike racks in articulated buses		Long-term	Low additional capital cost	Low	Yes
	Explore electric powered buses for new purchases	Penn State State College Borough	Long-term	Neutral to low net-positive	Medium	
<b>Travel Infrastructure</b>	Equip buses with bus-mounted enforcement cameras	Local and state legislatures	Medium-term	Net-positive	Very High	Yes
	Create bus stops at Rec Hall in both directions and southbound at the Walker Building	PennDOT	Fall 2020 Semester	Net-positive	Very High	Yes
	Create a pedestrian corridor through Rec Hall to access central campus	Penn State	Medium-term	Low capital cost	High	
	Implement transit signal priority on Burrowes Rd, College Ave, Beaver Ave, and select other intersections	PennDOT	Short-term	Low capital cost	Very High	
	Relocate stops to the far side of intersections, especially at the Walker Building and along Atherton St	All partner organizations	Medium-term	Low capital cost	High	Yes
	Install queue jumps at College and Allen and select other intersections	All partner organizations	Short-term	Low capital cost	High	Yes
	Create bus lanes at Pattee Transit Center	Penn State	Short-term	Net-positive	Very High	Yes
	Expand bus lanes along Curtin Rd	Penn State	Short-term	Net-positive	High	Yes

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Travel Infrastructure</b>	Expand bus lanes to Allen Rd and explore options for Park Ave	Penn State PennDOT	Long-term	Net-positive	Low	Yes
	Create curbside bus lanes on College Ave and Beaver Ave	PennDOT State College Borough	Medium-term	Net-positive	High	Yes
	Create curbside bus lanes on Atherton St	PennDOT State College Borough Ferguson Township Penn State	Medium-term	Net-positive	Medium	Yes
	Create and market an Atherton Hub		Medium-term	Neutral	Medium	Yes
	Create transitway on College Ave or Beaver Ave	PennDOT State College Borough	Long-term	High capital cost	High	Yes
	Create the Atherton Transitway	PennDOT State College Borough Ferguson Township Penn State	Long-term	High capital cost	High	Yes
	Continue the Atherton Transitway through downtown and south	PennDOT State College Borough	Long-term	High capital cost	Medium	Yes
	Remove on-street and surface parking to remove all local traffic and encourage transit use	<b>Penn State</b> <sup>123</sup> <b>State College Borough</b>	Ongoing	No additional cost	High	
	Build large classroom buildings near major bus stops	<b>Penn State</b> <sup>123</sup>	Ongoing	No additional cost	Very High	
	Rezone and redevelop lots near high-frequency transit, including along Atherton on the golf courses and through College Heights	<b>State College Borough</b> <sup>123</sup> <b>Penn State</b> <b>Surrounding Municipalities</b>	Ongoing	Revenue-generating	Very High	

<sup>123</sup> These projects would be led by organizations other than CATA.

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Network Changes</b>	Combine Red Link and Campus Shuttle services into two Red Link branches	Penn State	Fall 2021 Semester	Net-positive	Very High	Yes
	Reroute Red Link service through the Old Railroad Grade and add revenue hours from Green Link	Penn State State College Borough	Fall 2021 Semester	Net-positive	Very High	
	Create a stop at the Greenway near the Business Building to replace the Camps Shuttle stop	Penn State	Fall 2020 Semester	Net-positive	Medium	Yes
	Reroute Blue and White Loops along Stadium Dr and through a future mixed-use extension of downtown	Penn State State College Borough	Long-term	Net-positive	High	
	Reroute the White Loop through the Atherton Transitway and a transitway on College Ave or Beaver Ave		Long-term	Revenue-generating	Medium	Yes
	Connect the Old Railroad Grade with College Ave to create a unified corridor	Penn State State College Borough	Long-term	Net-positive	Low	
	Connect the Hospital to Porter Rd to remove the current Hospital detour	Penn State	Long-term	Low additional capital cost	Low	
	Advertise interlined RC/WE service along Atherton St		Fall 2019 Semester	Revenue-generating	High	Yes
	Interline VE/RC, NE/UT, and WE/HC routes and brand as three routes		Fall 2020 Semester	Revenue-generating	Very High	Yes
	Remove the VE/RC loop through Pattee Transit Center with the addition of a stop at Rec Hall		Fall 2020 Semester	Revenue-generating	Very High	Yes
	Extend NE/UT service to the Mall rather than to Bellaire Ave		Long-term	Medium additional operating cost	Medium	Yes

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
Network Changes	Increase trunk and adjunct route frequencies		With articulated buses	Medium additional operating cost	High	
	Expand adjunct route service frequencies and spans to create a full adjunct network		Long-term	Low additional operating cost	High	Yes
	Reschedule other routes on 40 minute and irregular schedules to consistent headways which repeat on the hour		Medium-term	Neutral	Medium	Yes
	Reroute the N corridor through the future Patton Crossing development and Park Forest Apartments	Patton Crossing developers, <sup>124</sup> Park Forest Apartments owners	With Patton Crossing, long-term	Net-positive	High	Yes
	Reroute W, WE, NV, and VN service through the new Pine Hall development	Pine Hall TTD developers <sup>125</sup>	With Pine Hall, medium-term	Net-positive	High	Yes
	Reroute the KP route on Circleville Rd and Science Park Rd, alter F service, and eliminate S service		With Pine Hall, medium-term	Neutral	Medium	Yes
	Reroute service to Bellefonte via I99 or Route 550	Patton Township <sup>126</sup>	Medium-term or with Patton Twsp development	Revenue-generating	Medium	Yes
	Increase frequency of XB and XG routes to hourly		Medium-term	Net-positive	Medium	

<sup>124</sup> Penn Terra Engineering, Inc., "Patton Crossing Master Plan," Patton Township, June 24, 2019, sheet 5.

<sup>125</sup> LandDesign, "Pine Hall Traditional Town Development General Master Plan: Phasing Plan," Ferguson Township, February 15, 2018.

<sup>126</sup> Penn Terra Engineering, Inc., "Nittany Valley Sports Centre Revised Master Plan #3," Patton Township, May 31, 2019.

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Network Changes</b>	Remove the loop through Park Forest on the A route, and consider extending it toward Gray's Woods		Fall 2020 Semester	Revenue-generating	Low	Yes
	Shrink or eliminate the loop through Boalsburg on the B route		Fall 2020 Semester	Revenue-generating	Low	Yes
	Add stops for the adjunct network near commercial centers to bypass parking lot detours		Spring 2020 Semester	Revenue-generating	High	Yes
	Add additional stops at the Park on the W and WE routes and at The View/The Valley on the HC route		Spring 2020 Semester	Revenue-generating	Medium	Yes
	Create pedestrian and bike connections between Bellaire Ave and College Ave, Atherton St and Martin St, Galen Dr and Valley Vista Dr, Bayberry Dr and Southgate Dr, future Patton Crossing development and Park Ln, Premiere Dr and Benner Pk, and the Oakwood Ave loop	Centre Regional Planning Agency	Short-term	Low capital cost	High	
	Create pedestrian and bike connections between Barnstable Ln and Science Park Rd, The Landings and Sylvan View, Westway Gardens and Shamrock Estates, Fox Hollow Rd and Woodledge Dr/The Village, and Greenleaf Manor and Northwick Blvd	Centre Regional Planning Agency	Medium-term	Low capital cost	Low	
<b>Network Legibility</b>	Roll out new system maps online, on mobile apps, in buses, at stops, and with community partners		Fall 2019 Semester	No additional cost	Very High	Yes
	Update route color schemes on map and bus locator apps		Fall 2019 Semester	Neutral	High	
	Roll out new stop info panels online and at stops, with 6" x 24" panels		Fall 2020 Semester	Low additional capital cost	High	Yes
	Create the necessary infrastructure to automate the process of updating stop info signs from GTFS data		Before stop info panel rollout	Net-positive	High	

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
<b>Network Legibility</b>	Transition official stop names to names of major destinations		Ongoing	Neutral	Medium	
	Add route stickers to Community Service bus stops		Fall 2020 Semester	Low capital cost	Low	Yes
	Upgrade bus location trackers to move smoothly		Short-term	Low capital cost	High	
	Use the frequent network to help plan dense, mixed-use development and help students make informed decisions about apartment locations	Penn State State College Borough Surrounding Municipalities Apartment landlords	Ongoing	Revenue-generating	Very High	
<b>Organization Cooperation</b>	Create truly unlimited apartment passes and phase out corridor passes	Apartment landlords	Fall 2020 Semester	Net-positive	Very High	Yes
	Encourage all existing and new developments to include transit passes in rent	State College Borough Surrounding municipalities	Ongoing	Revenue-generating	High	
	Incentivize downtown developers to pay for transit by eliminating parking requirements	State College Borough	Short-term	Revenue-generating	Very High	
	Create guidelines for event road closures and temporary bus lanes	Penn State State College Borough	Short-term	Revenue-generating	High	Yes
	Create an ordinance which requires CATA's approval for road closures	State College Borough	Medium-term	Revenue-generating	Medium	
	Negotiate with Penn State to allow Loops to serve their normal routes during football games	Penn State	Short-term	Net-positive	High	Yes
	Negotiate with Penn State to use the Blue Loop as the Parents' Weekend Trolley	Penn State	Medium-term	Revenue-generating	Low	Yes
	Adopt a priority merge rule and post signs at bus pull-offs	All partner organizations	Short-term	Net-positive	High	Yes

Category	Project	Supporting Organization	Timeline	Cost	Priority Level	Potential for Pilot
Organization Cooperation	Share youth pass benefits with local school district parents	State College Area School District Bellefonte Area School District	Medium-term	Revenue-generating	Low	
	Enforce clearing of snow at bus stops, especially downtown	State College Borough	Short-term	Neutral	High	
	Create a free transit program and transit validation program for parity with the free parking and parking validation programs downtown	State College Downtown Improvement District	Long-term	Medium additional operating cost	Low	Yes
	Add median treatments to disallow passing cars at Burrowes Rd at Westgate Building, 805 S Atherton St and S Atherton St at Pizza Hut, and S Burrowes St at the James Elliott Building	All partner organizations	Medium-term	Low capital cost	High	Yes
	Require shelters at new stops and add shelters to existing stops to vastly expand shelter coverage	All partner organizations	Medium-term	Low additional capital cost	High	
	Create an ordinance which requires development near bus stops downtown and on campus to provide indoor shelter	Penn State State College Borough	Long-term	Neutral	Medium	
	Explore near-level boarding at high-ridership stops	Penn State State College Borough	Long-term	Medium capital cost	Low	
	Develop procedures for reviewing development plans before the sketch plan phase	Centre Regional Planning Agency All municipalities	Short-term	Revenue-generating	Very High	Yes

Supporting Documents . Images

## Appendix

See the data behind conclusions from this report and start making improvements with completed graphics

# Supporting Documents

Download all supporting documents:  
[jamesgraef.com/cata-operations/appendix](http://jamesgraef.com/cata-operations/appendix)

## DATA

[Raw data about dwell time, trip time, bus type \[Excel 3.2 MB\]](#)

[Shelter status of bus stops \[kmz 80 KB\]](#)

[Shelter status of bus stops: Google My Map](#)

[Atherton Transitway Sketch Plan: 3dm \[ZIP 27.6 MB\]](#)

## GRAPHICS

CATA System Map:

[PDF, 2 pages \[PDF 4.5 MB\]](#)

[Image, outside \[PNG 1.7 MB\]](#)

[Image, inside \[PNG 2.4 MB\]](#)

[Editable Illustrator File \[ZIP 11.4 MB\]](#)

Stop Info Panels:

[PDF, 8 samples \[PDF 6.9 MB\]](#)

[Editable Illustrator File \[ZIP 6.8 MB\]](#)

Advertisement Graphics:

[PDF, 4 sample ads \[PDF 9.1 MB\]](#)

[Editable Illustrator File \[ZIP 8.0 MB\]](#)

[6 bus vectors with all numbers of doors \[ZIP 319 KB\]](#)

# Images

All images are the author's unless noted.

Current maps and information panels; background road map:  
[catabus.com](http://catabus.com)

Aerial images: [Google Maps](#)





